MECHANICAL ENGINEERING

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Steam is literally the lifeblood of our American economy. Through it, the energy in our store of fuels is made available in useable form. Steam has always been taken for granted because it's cheap. But, with the depletion of top grade coals, with the increase in price of fuels generally, major engineering concentration is required on the problem of . . . . . .

keeping steam cheap

B&W CYCLONE FURNACE

A prominent Eastern utility engineering executive calls the B&W Cyclone Furnace the most important development in the power plant field in the last 30 years. . . . Another well-known utility executive ranks it with the steam turbine. We, in B&W, regard the Cyclone Furnace as one of our most important contributions to power plant engineering progress.

The Cyclone Furnace is important because it has simplified fuel-burning problems, and permitted efficient, economical use of a wide range of coals. More than a dozen different kinds of coal already have proved eminently satisfactory in service, and many more grades are showing promise under test.

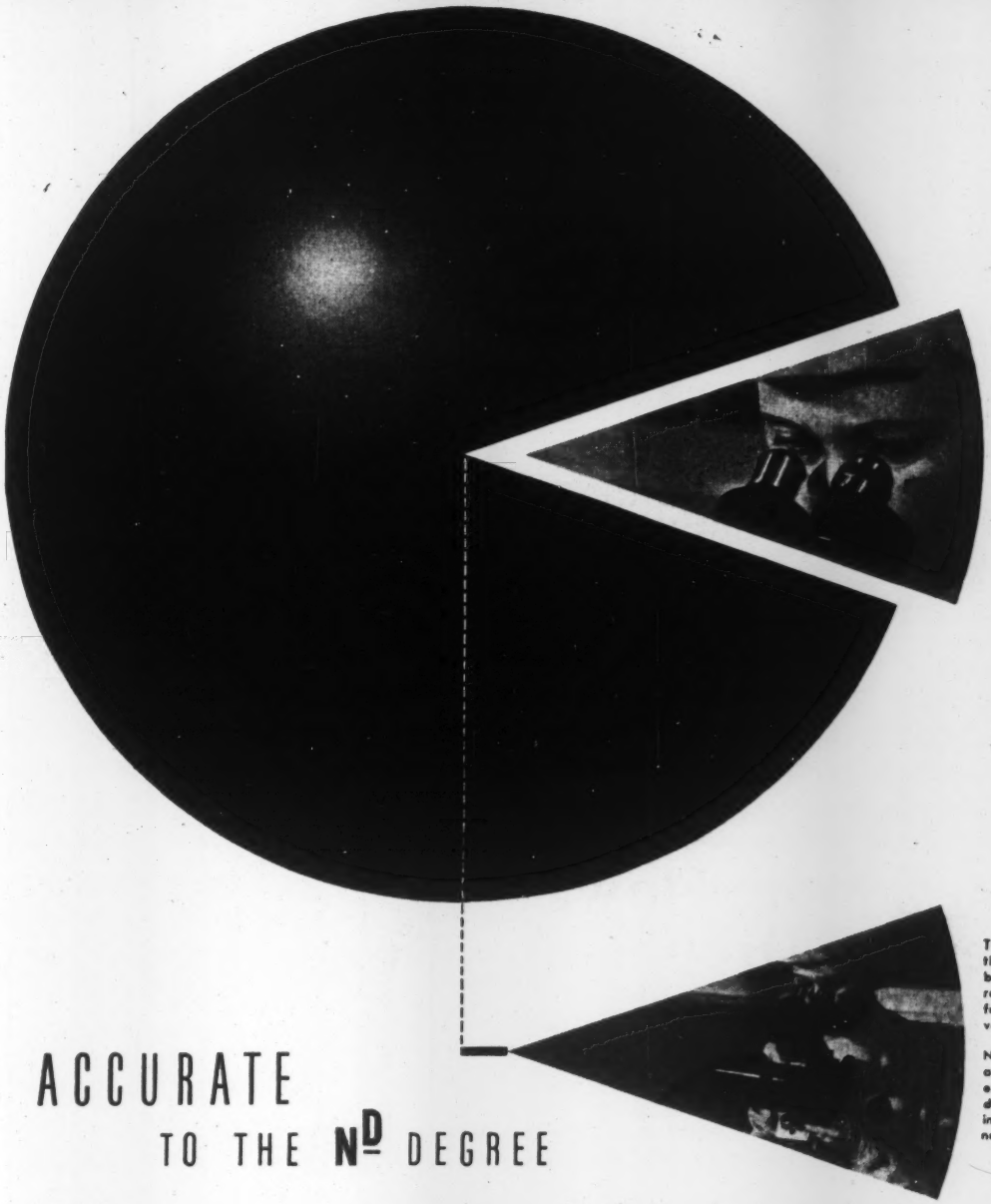
Already, B&W's revolutionary method of coal-firing has been selected for a total of 32 boilers with aggregate steam capacity of more than twenty million pounds per hour . . . sufficient to serve over two million kw of new electric generating capacity.

Keeping steam cheap . . . for public utilities and industrial users . . . is a prime engineering objective at B&W. The Cyclone Furnace is one of many B&W cost-saving advantages worth investigating.

BABCOCK & WILCOX

BOILER DIVISION

N-156



Typical of the careful inspection which New Departure bearing parts must undergo, a raceway is checked by powerful microscope which could reveal the most minute flaw.

New Departure ball bearings are readily available at your equipment dealer or bearing distributor—supplied from the industry's largest nation-wide network of warehouse stocks.

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TO THE ND DEGREE

Today's machines . . . automobiles or aircraft . . . conveyors or combines . . . recording instruments or radar installations . . . require accurate, low friction support for their moving parts. Where ball bearings are best for this job, the *best ball bearings* are New Departures, because of the highest quality standards in the industry.

For many New Departure bearings the diameter and roundness of the balls are held within the limits of a few millionths of an inch. And other parts of the bearings . . . rings, races, separators and seals . . . must pass batteries of scientific inspection devices and skilled operators, before and after assembly.

If an application calls for ball bearings of pre-determined accuracy and life expectancy, install New Departures. Keep your eye on the BALL to be sure of your BEARINGS!

NOTHING ROLLS LIKE A BALL

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BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Also Makers of the Famous New Departure Coaster Brake

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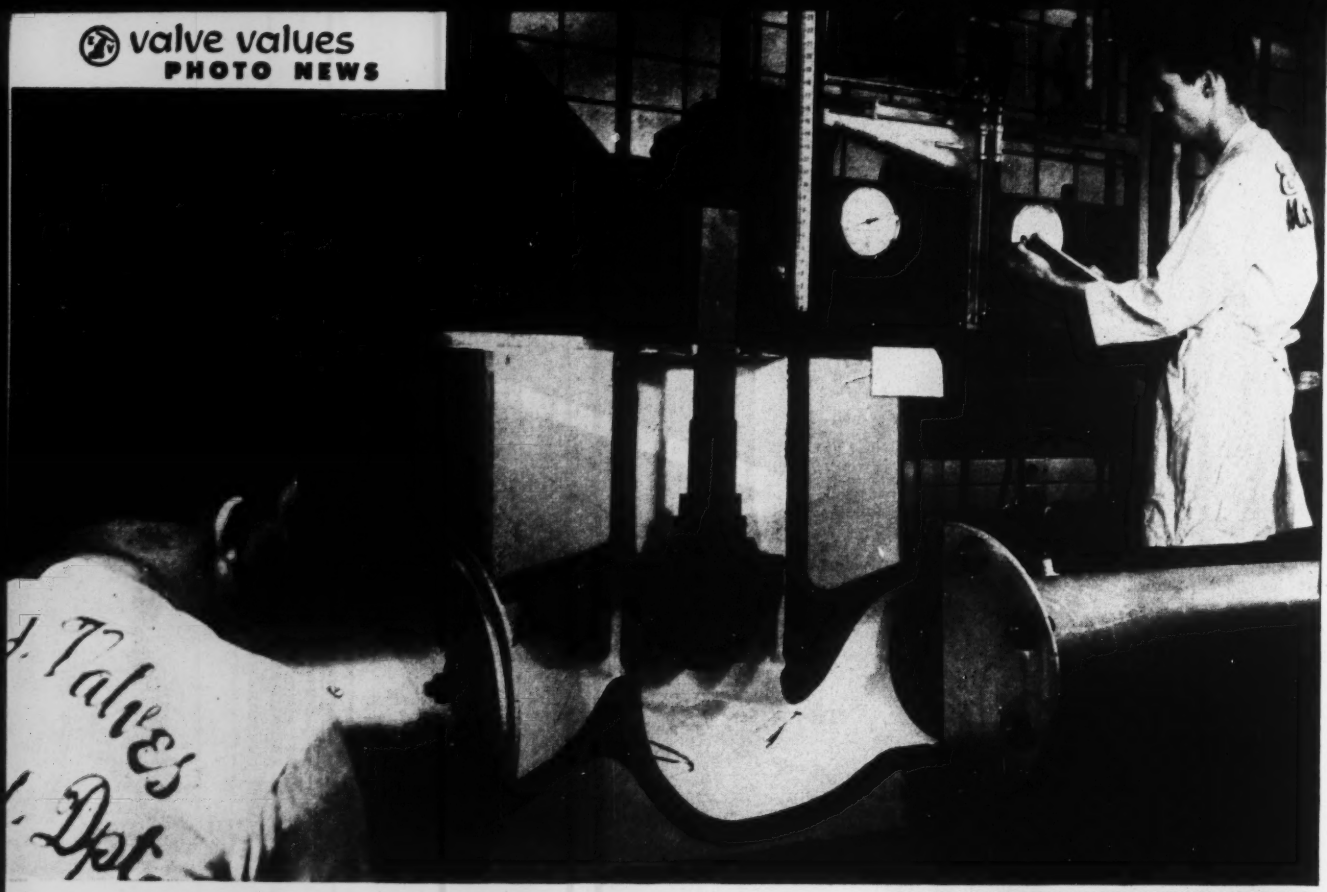
valve values
PHOTO NEWS



Up to 30% More Flow, Less Pressure Drop, FOR EDWARD VALVES

One of the basic first steps in the development of any new valve design at Edward is the thorough analysis of its flow characteristics and the precise determination of pressure drop. No guesswork is tolerated. Exclusive laboratory techniques permit technicians to actually see flow through the proposed design and to measure precisely all flow characteristics.

Plastic "half-models," as illustrated, are placed in specially designed flow equipment where pressure loss can be readily and minutely measured. Through the use of streamers, colored smokes and special measuring techniques, pressure-stealing, wear producing turbulence and other flow phenomena are revealed to the researcher's trained eye, thus readily corrected. Change after change is made in the plastic model until the design with the greatest possible flow and least possible pressure loss and turbulence has been evolved.

Plaster casts are then made, sectioned, and carefully measured with specially developed equipment. The pattern maker's art and the latest foundry and forging processes then transform the experimental plastic "half-model" into a full scale steel valve with minimum pressure drop and up to 30% greater flow than ordinary valve constructions.

At Edward the determination to omit no painstaking design step has contributed greatly to the development of valve designs that are today the most copied in the field. Dozens of features that were Edward "firsts" are now industry standards. And many patented features are still exclusive with Edward.

Plaster cast of valve design having best flow characteristics is sectioned and minutely measured so that patterns for top quality valve production can be made.

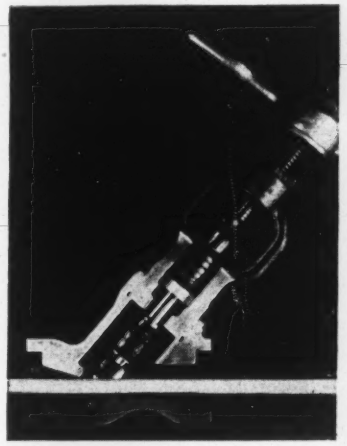
Flow equipment tests full scale experimental or finished steel valves—above a 10-inch 900-lb sp Non-Return valve undergoing flow test. Flow meters and gages indicate pressure changes, other flow data.

Edward Valves, Inc. Another Product

25-50% Less Pressure Drop, Lower Maintenance with
EDWARD UNIVALVES

In Edward Univalves, all-purpose globe valves for high temperature-pressure service, streamlined internal contours and a patented inclined stem construction provide straight-through flow, as illustrated below. As a result, tests have proven this all forged steel valve to have a pressure drop 25 to 50% lower than other types of globe valves. The streamlined contours also minimize turbulence, thus adding life to internal parts by eliminating the principal cause of wear producing vibration.

These advantages, plus many other features, have over the last ten years established the Univalve (T.M. REG.) as the industry standard for tough applications. For example, many Univalves are used in punishing blowoff service. They meet all ASME boiler code requirements for blowoff valves and are ideal for boiler pressures from 600 to 3120 lbs.



A patented body-bonnet joint consisting of a shoulder, a threaded connection, a guiding section and a seal weld assures perfect alignment and pressure tightness in any service. The seal weld may be readily removed for repair of seating surfaces damaged by foreign matter being trapped in the valve.

Use of heavy stellite ring on body and disk seating surfaces assures long life in high temperature service. Seats are integral with body, and are machined in same set-up with body bore for perfect alignment. Wide contact faces on seating surfaces are carefully lapped and mated to insure positive shut-off.

Special attention has been given to the packing, necessarily the most vulnerable spot in any valve of this type. A positive engineered backseat completely isolates packing chamber from the line pressure when valve is full open, stretching packing life. If repacking becomes necessary, this backseat permits replacement of packing while valve is under full line pressure.

Univalves are furnished in 1500 and 2500 lb. pressure classes in sizes from ¼ in. to 2 in. Valves over 1 in. have Impactor Handle, 2.8 times as effective as ordinary handwheel, as standard equipment. Univalves are normally supplied with socket ends, although screwed ends and flanged ends are available on special order.

Write for Catalog 12 G1 for complete information.

EDWARD VALVES, Inc., *Subsidiary of*
ROCKWELL MANUFACTURING COMPANY
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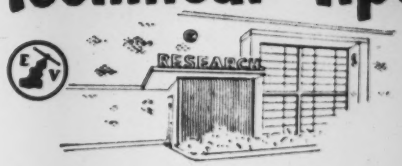
Technical Tips

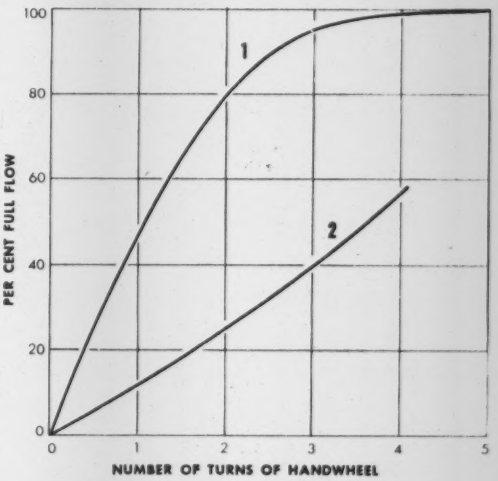


Use of Globe Valves for Throttling Service

Experience has shown that globe valves are to be preferred in locations which require tight shut-off and services which may call for throttling. Forged steel inclined stem globe valves give many of the free flow characteristics typical of gate valves and combine the tightness and ability to throttle characteristic of globe valves.

The chart below shows the flow characteristics of typical inclined stem forged steel globe valves in relation to handwheel opening. Curve No. 1 shows the per cent of full flow capacity flowing through an inclined stem globe stop valve for each successive turn of the handwheel up to five. The major portion of the throttling control takes place in the first two turns of the valve handwheel. The amount of flow is essentially a straight line variable within this range.

For comparison, a typical globe valve with V-port throttling disk is shown on the same chart. The V-port valve is designed to give less flow per handwheel turn so that closer regulation can be obtained. However, in the wide open position the total is only about half that of a general purpose inclined stem globe stop valve.



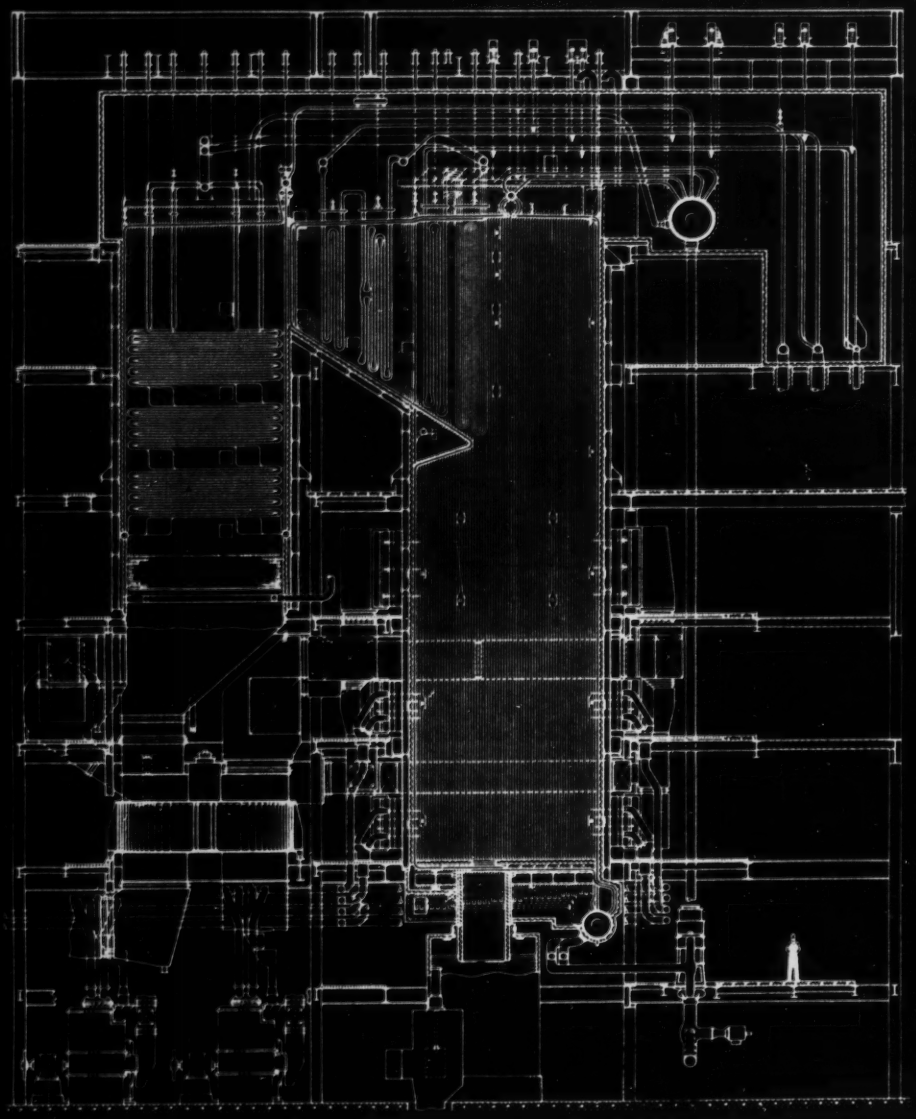
1. Globe Stop Valve 2. V-Port

Globe stop valves are sometimes installed as variable volume regulators in carefully calibrated flow systems, but their widest use lies in general purpose installations. The curve shows that a few simple rules can be followed for throttling operations. A half turn open gives about ¼ flow, one turn open about ⅓ flow, two turns open about ¾ flow.

When closing down from the wide open position, the rule is not so simple. Different sizes and figure numbers of inclined stem globe valves will have different numbers of handwheel turns from wide open to closed. If a rough measure of throttling is desired, it is best to close the valve down and then open a certain number of turns rather than to try to close from the wide open position with a specific number of turns.

Edward

KEARNY.....



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ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

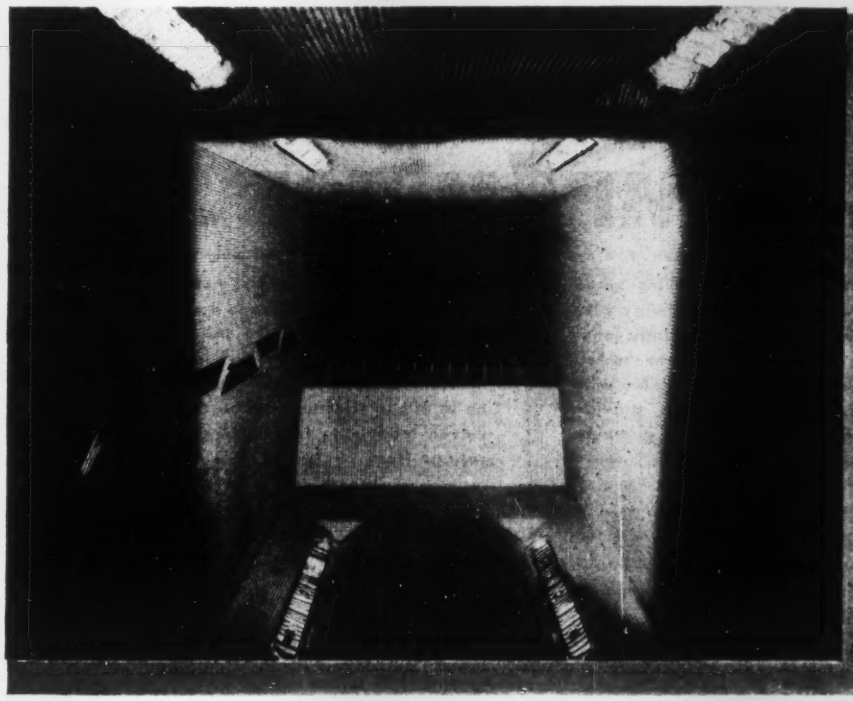
. . . starts up WORLD'S FIRST 1100 F, 2650 psi BOILER

March was a significant month for both Public Service Electric & Gas Company and Combustion Engineering. It was "starting up" time for preliminary trial runs of the equipment comprising the new extension of P.S.E.&G's Kearny Generating Station at Kearny, N. J.

But this was not just another "starting up" of a large utility installation. It was something special for all concerned because it brought to Kearny the distinction of being the first power station in the world to use a steam temperature as high as 1100 F and a turbine throttle pressure of 2350 psi.

The Kearny boiler is also notable as one of the first controlled circulation boilers of the modern reheat type to go into service. Designed for a pressure of 2650 psi, it has been hydrostatically tested to 4000 psi. It will supply steam to a 145,000-kw turbine-generator at a primary temperature of 1100 F, reheated to 1050 F. A duplicate installation is scheduled for service this summer.

Combustion Engineering is proud to be associated with the advancements in steam-power practice which the Public Service Electric & Gas Company has achieved at Kearny.



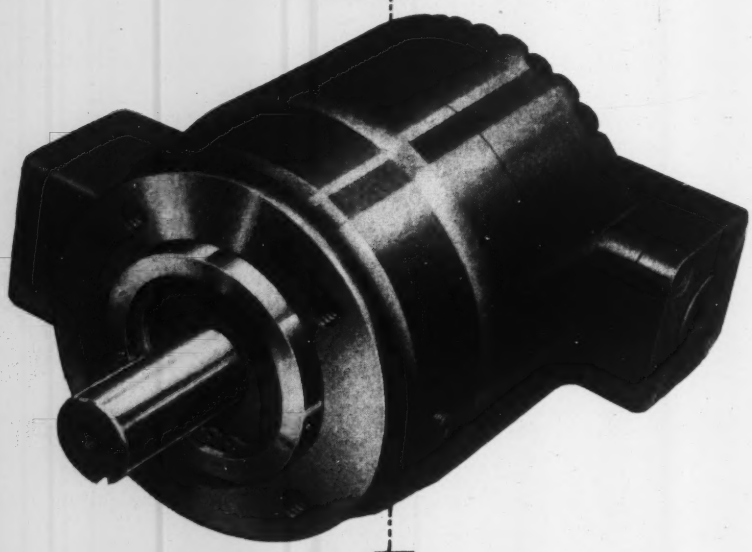
View looking upward from bottom of furnace showing tilting tangential burners, center wall at left and platen type superheater in middle area.

— SUPERHEATER, INC.
200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

Designed Right

for **both** jobs



Ready for use as either PUMP or MOTOR without adjustments

On pump applications, you get extra value from Pump/Motors—high volume oil delivery plus husky, close-coupled design that withstands *long, hard, continuous duty* at all pressures up to the full 2000 psi maximum. Four sizes, each available with a choice of cam rings for varying needs, provide a total of sixteen different models with pumping capacities ranging from 3 to 70 gpm.

For fluid motor needs, Pump/Motors give you smooth-running, high-torque operation plus compact ruggedness that can take the punishment of continuous operation under full load. The ideal transmission for rotary drive needs! Shaft rotation can be in either direction without internal adjustments. Eleven models in four different sizes offer torque ratings from 13 to 257 inch-pounds per 100 psi.

Pump/Motors are *designed right*—for heavy-duty 2000 psi requirements—for complete hydraulic balance—for dual-purpose efficiency—for simplicity—for longer life—for lower maintenance cost—for quick, economical adaptation to the widest possible range of *pump and motor needs.* Compactly built in three simple, sturdy components, they feature quickly interchangeable cam rings . . . no changes necessary for either clockwise or counterclockwise rotation . . . and full hydraulic balance in both *vanes and rotor.* They're today's biggest value for both *pump and motor* requirements in the 2000 psi range. Write today for Pump/Motor Bulletin P-5.

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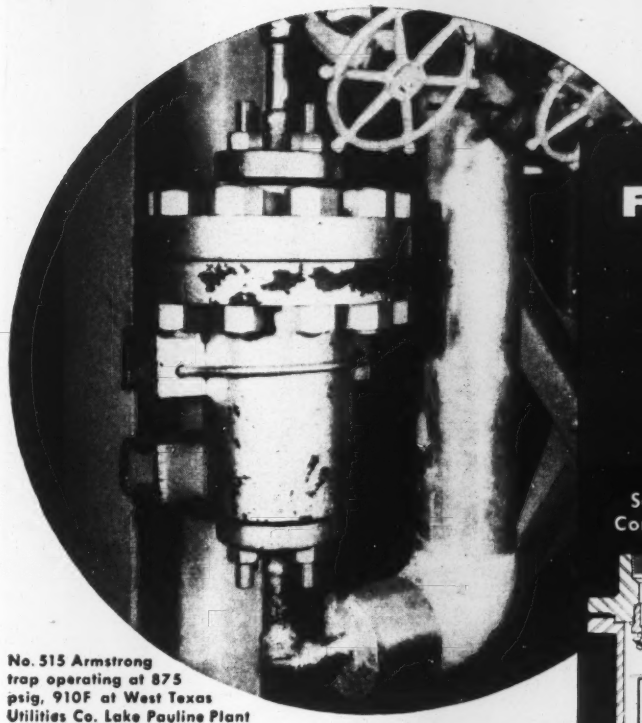
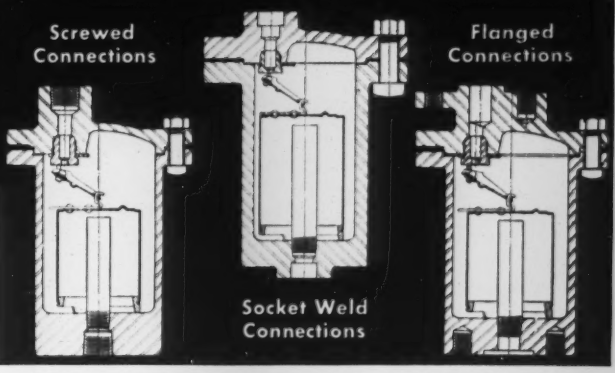
Denison makes pumps, pumping units, controls and fluid motors for circuits up to 5000 psi—They're **"The Finest Money Can Buy!"**



No. 515 Armstrong trap operating at 875 psig, 910F at West Texas Utilities Co. Lake Pauline Plant

FOR HIGH PRESSURE CONDENSATE DRAINAGE...

(UP TO 2400 LBS.)*



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ARMSTRONG FORGED STEEL STEAM TRAPS!

Because:

1. *They provide dependable automatic drainage* of condensate and boiler carryover for protection of valves, turbines and other equipment.

2. *They have been thoroughly proved* in use in important power plants all over the world.

3. *Armstrong has built thousands of them* since 1929 and has the experience necessary to insure safe design and application. In fact, Armstrong pioneered the development and application of traps for high pressures and has continuously kept pace with the trend to higher pressure plants.

4. *Generous margins of safety are provided,* not only in the forged bodies and caps, but in the power provided for opening the valve and in bucket buoyancy for closing the valve. There is no steam waste and no failure to open.

5. *The quality is unsurpassed*—chrome steel valve and seat are hardened, ground and lapped; other working parts are stainless; bodies, caps and bolts and nuts are of materials approved for pressures involved.

6. *The cost is moderate*—first cost because of quantity production, long run cost because of low maintenance.

7. *They are guaranteed to give complete satisfaction.* Your local Armstrong Representative is fully qualified to discuss your forged steel trap applications and to answer your questions. Give him a call, or write:

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* Many plants, particularly refineries and chemical processing plants use Armstrong forged steel traps at 250 lbs., or less, pressure to secure the advantages of all-steel fittings and freedom from damage in event of fire or explosion.

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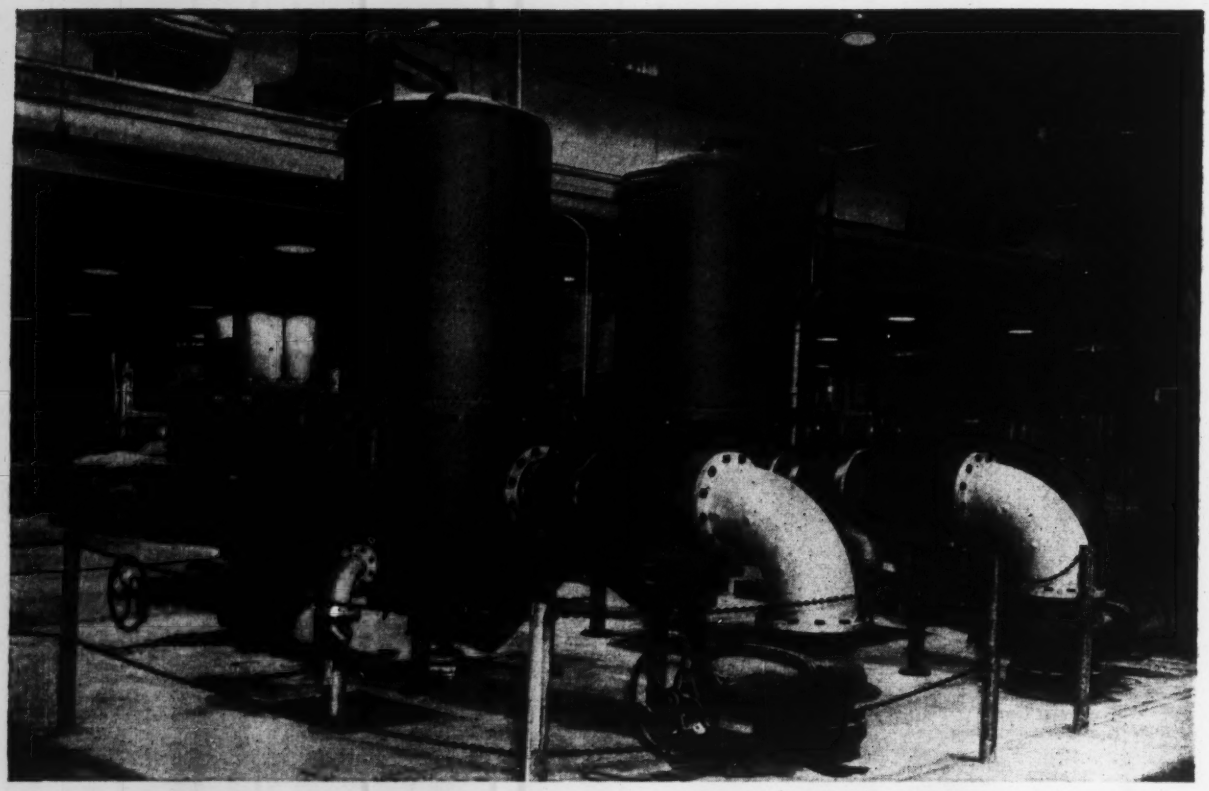
Send for the new 44-page Steam Trap Book—includes physical data and list prices, service pressure rating tables, list of materials and other data pertinent to forged steel traps *plus* information on cast traps and trap selection, installation and maintenance for all condensate drainage jobs. Free on request—no obligation.

ARMSTRONG STEAM TRAPS



EVERY GRAIN OF SAND IS REMOVED from the well water passing through these abrasion-resistant FLO-KLEAN filters at the new Upjohn Company plant in Kalamazoo, Michigan.

Upjohn saves 2000 dollars a month

FLO-KLEAN filters protect valuable equipment at pharmaceutical plant

Maintenance records at the Upjohn Company's ultra-modern plant near Kalamazoo, Michigan, show that FLO-KLEAN filters are responsible for saving up to $2000 a month in maintenance costs.

These Cuno FLO-KLEAN filters, used to remove sand and gravel from incoming well water, ordinarily take something like a teaspoon of sand out of each thousand gallons. That doesn't appear to be an impressive quantity, but it could cause serious damage to stainless steel valves, pumps, water softeners, condensers and other valuable equipment. Purity of process water is assured by the high-capacity FLO-KLEAN units.

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In hundreds of applications throughout industry the fully automatic, continuously self-cleaning FLO-KLEAN filters have paid for themselves many times over by making river, lake, or well water fit for industrial use . . . and without loss of backwash water. Other uses include reclaiming industrial process water and coolants. If you need or use between 200 and 100,000 gallons per minute of clean water, find out how FLO-KLEAN can save you money. Write for free FLO-KLEAN bulletin to the Cuno Engineering Corporation, Dept. 651F, Meriden, Conn. 3.1

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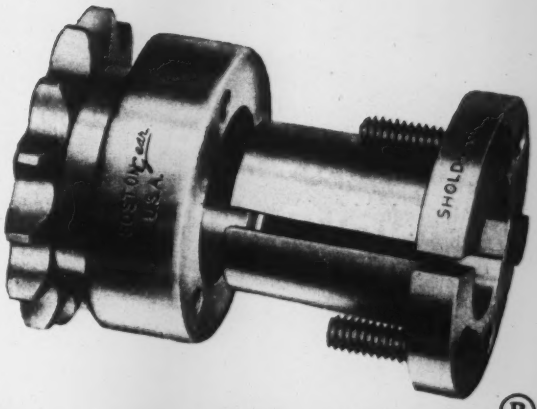

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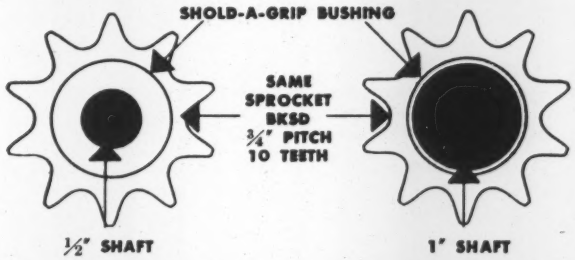
BUSHINGS AND SPROCKETS

BROADER SIZE RANGE. FIT SHAFTS ½" to 2½" by 16ths

Any commonly used sprocket, ½" to 2¼" pitch, can be interchanged on an extended range of shaft sizes. SHOLD-A-GRIP's high-strength design restricts screw holes to sprocket shoulder. Thus, many smaller sprocket sizes are added to the interchangeable class.

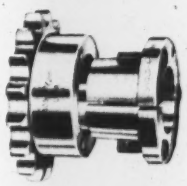
ONE SPROCKET FITS MANY SHAFT SIZES SIMPLY BY CHANGING THE BUSHING



Example: Sprocket BKSD, ¾" pitch, 10 teeth, can be used on 9 different shaft sizes, any size from ½" to 1" by 16THS, by inserting the correct size SHOLD-A-GRIP Bushing.

Illustration at top of page is typical design of SHOLD-A-GRIP Bushing and Sprocket with minimum number of teeth.

Illustration at right is typical of design of SHOLD-A-GRIP Bushing and Sprocket with maximum number of teeth.



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Boston Gear expert engineering has provided a correct taper in SHOLD-A-GRIP Bushings and Sprockets for slip-proof grip. When screws are tightened the bushing grips both sprocket and shaft with maximum holding power, even on shafts which vary from true diameter.

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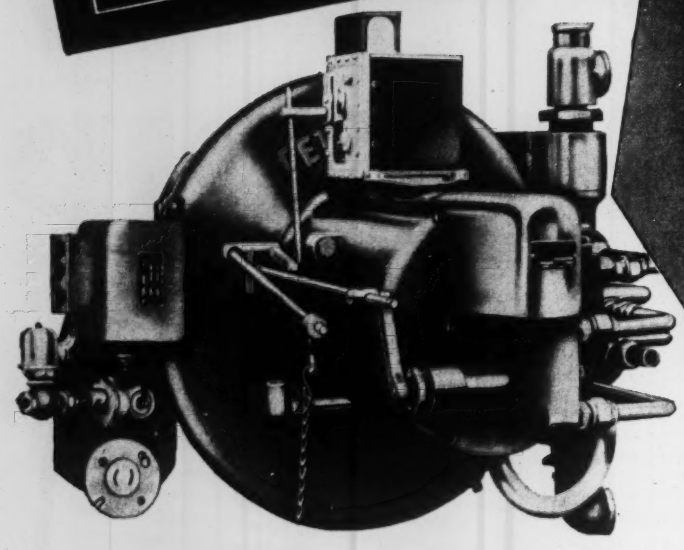

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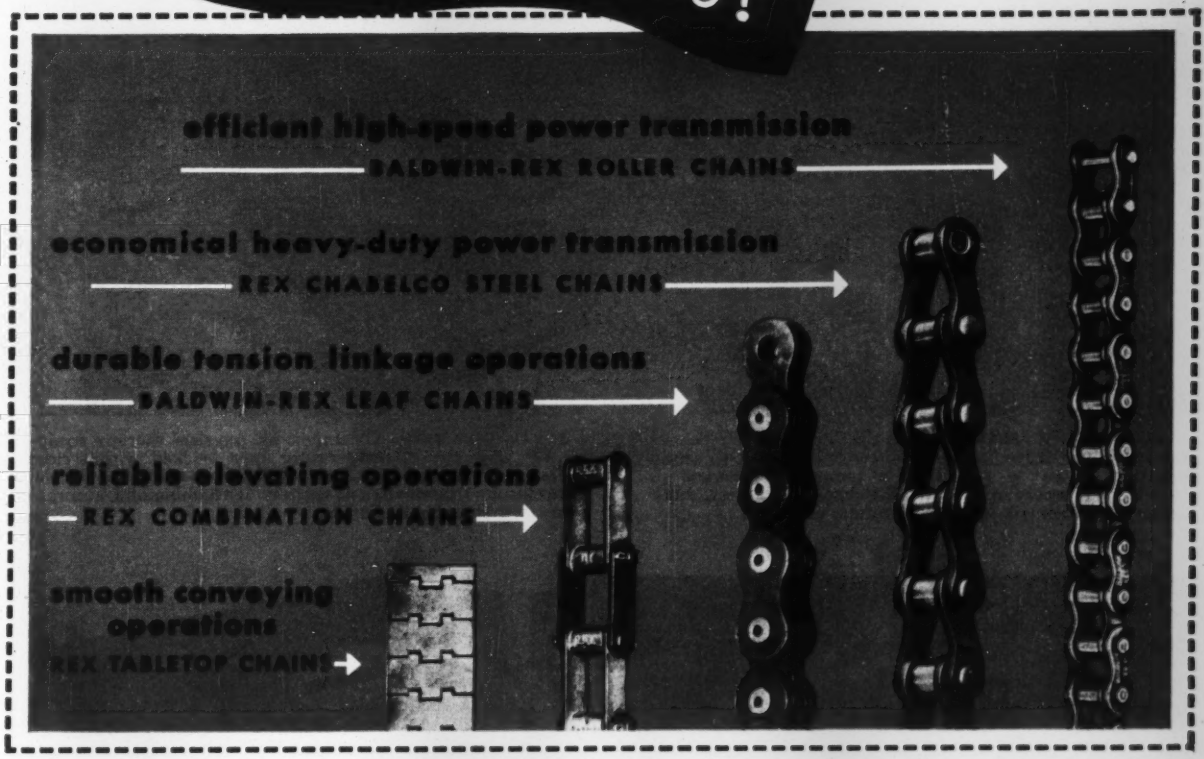

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2. PARAFFIN BATHS are important physical therapy equipment. For safety, temperature must be held within close limits. Makers of Dickson Paraffin Baths selected Fenwal THERMOSWITCH devices as entirely dependable and accurate in controlling heating unit.

3. A FENWAL THERMOSWITCH CONTROL may solve your problems, too. Its external, single-metal shell expands or contracts *instantly* with temperature changes, making or breaking enclosed electrical contacts. Compact, highly resistant to shock and vibration, Fenwal THERMOSWITCH units have solved hundreds of otherwise costly problems.

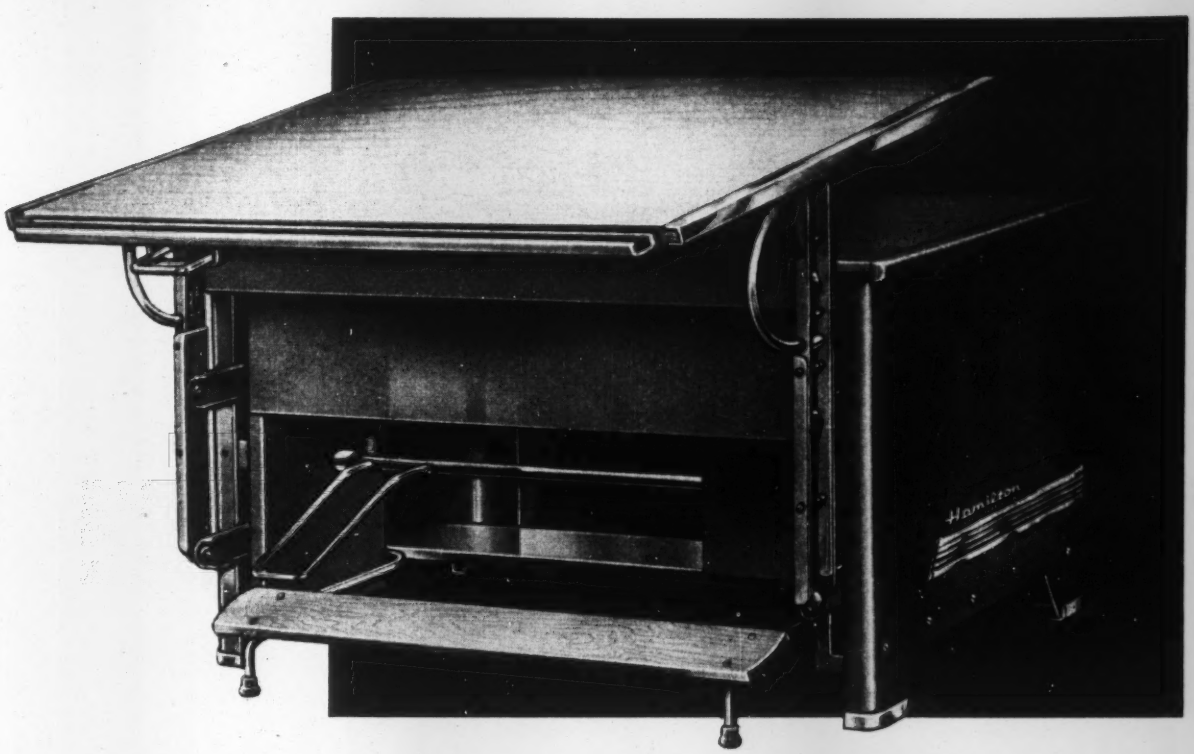
4. SEND FOR THIS NEW CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. **Write Fenwal Incorporated, 55 Pleasant Street, Ashland, Massachusetts.**

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE... *but only to heat*



the new Auto-Shift

TM Reg.

by Hamilton

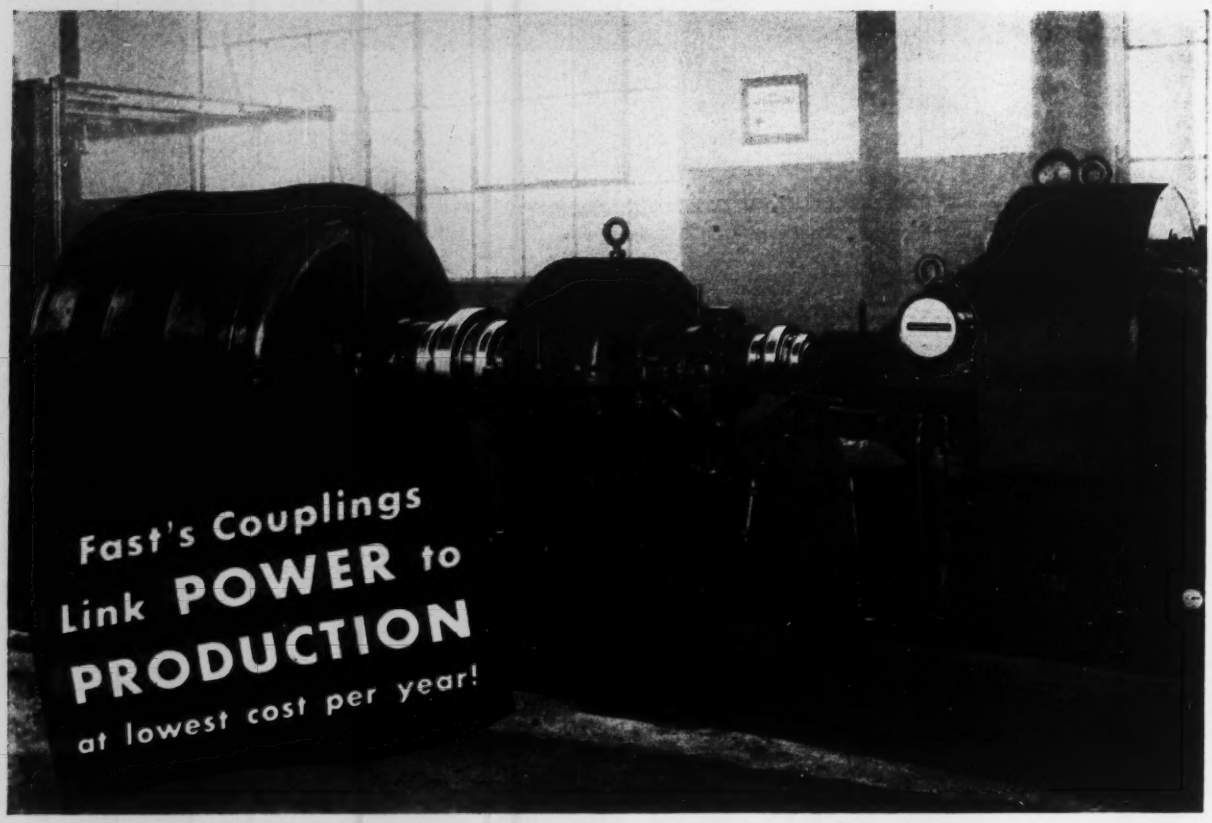
America's most efficient, most *fatigue-free* drafting table has been completely redesigned—improved in many functional details, smartened in appearance and broadened to accommodate an entirely new range of drafting table needs. Yes, the new Auto-Shift line well deserves your interest—for it has been tailored precisely to your needs.

Here are a few highlights. The basic Auto-Shift table is now available in two base sizes, each with two board sizes. For row installations, two new front-end Auto-Shifts (board only) and two new rear-end units (reference desk only) are available. As always, the Auto-Shift features instant, effortless adjustment of board height and slope, and remarkably high floor space efficiency.

You owe it to yourself to find out more about this exceptionally fine drafting table, and Hamilton's new 8-page Auto-Shift brochure is the best possible way to do this. For your free copy, write today to—

Hamilton Manufacturing Company

TWO RIVERS, WISCONSIN



Every major producer of high-speed equipment uses FAST'S Couplings!

HIGH-SPEED equipment demands components with superior strength, accurate manufacture, long-lasting dependability. That's why it's important to *you* that Fast's Couplings are selected by every major high-speed equipment producer!

Fast's usually outlast the equipment they connect. Many have been in continuous operation for over 30 years, without trouble of any kind. And Fast's longer life saves you coupling dollars, too, because you amortize their cost over many years of trouble-free operation.

For full details on Fast's Couplings and Koppers Engineering Service, write today for your free copy of our catalog. Send to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 255 Scott St., Baltimore 3, Maryland.

KOPPERS®

FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*
255 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

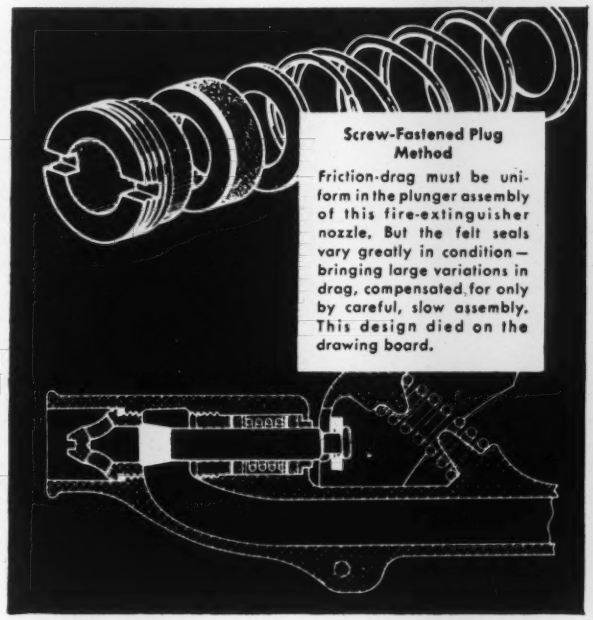
Name .....

Company .....

Address .....

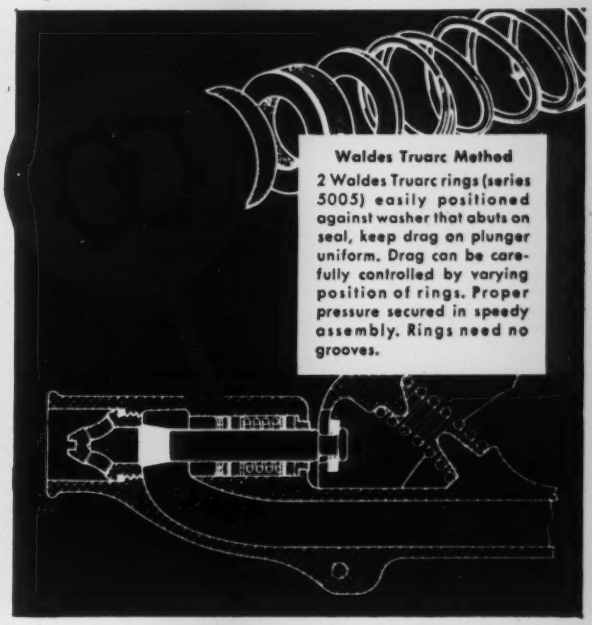
City ..... *Zone* ..... *State* .....

2 Truarc self-locking rings replace threaded plugs. Save 6¢ per unit, speed assembly by 140%.



Screw-Fastened Plug Method

Friction-drag must be uniform in the plunger assembly of this fire-extinguisher nozzle. But the felt seals vary greatly in condition—bringing large variations in drag, compensated for only by careful, slow assembly. This design died on the drawing board.



Waldes Truarc Method

2 Waldes Truarc rings (series 5005) easily positioned against washer that abuts on seal, keep drag on plunger uniform. Drag can be carefully controlled by varying position of rings. Proper pressure secured in speedy assembly. Rings need no grooves.

Ansul Chemical Company's new watertight precision nozzle for their dry chemical fire extinguisher replaces conventional stainless steel plug with two Waldes Truarc Self-Locking Retaining Rings and washer. Rings hold entire nozzle packing securely in place — keep friction drag of plunger uniform. Adjustable in final assembly, Truarc rings speed production from 25 to 60 units per hour. They save 6¢ per unit in overall costs, 1/8" in length.

Redesign with Waldes Truarc Rings and you, too, will save on assembly, time, improve product performance, facilitate easier servicing of whatever you make.

Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together. They're precision-engineered . . . quick and easy to assemble and disassemble. They give a never-failing grip. Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

WALDES TRUARC RINGS MADE THESE SAVINGS POSSIBLE—

Discarded Design		Truarc Design	
Parts:	Cost Per Unit	Parts:	Cost Per Unit
threaded stainless steel plug	$0.0675	2 rings	$0.0146
Direct Labor	$0.0350	1 washer	$0.0280
	$0.1025		$0.0426

Total savings per unit with Truarc Rings $.0599

For precision internal grooving and undercutting . . . Waldes Truarc Internal Grooving Tool.

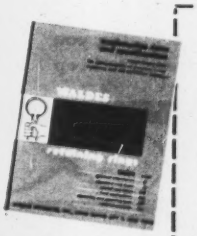
SEND FOR NEW CATALOG

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS



WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog. ME 055

(Please print)

Name.....

Title.....

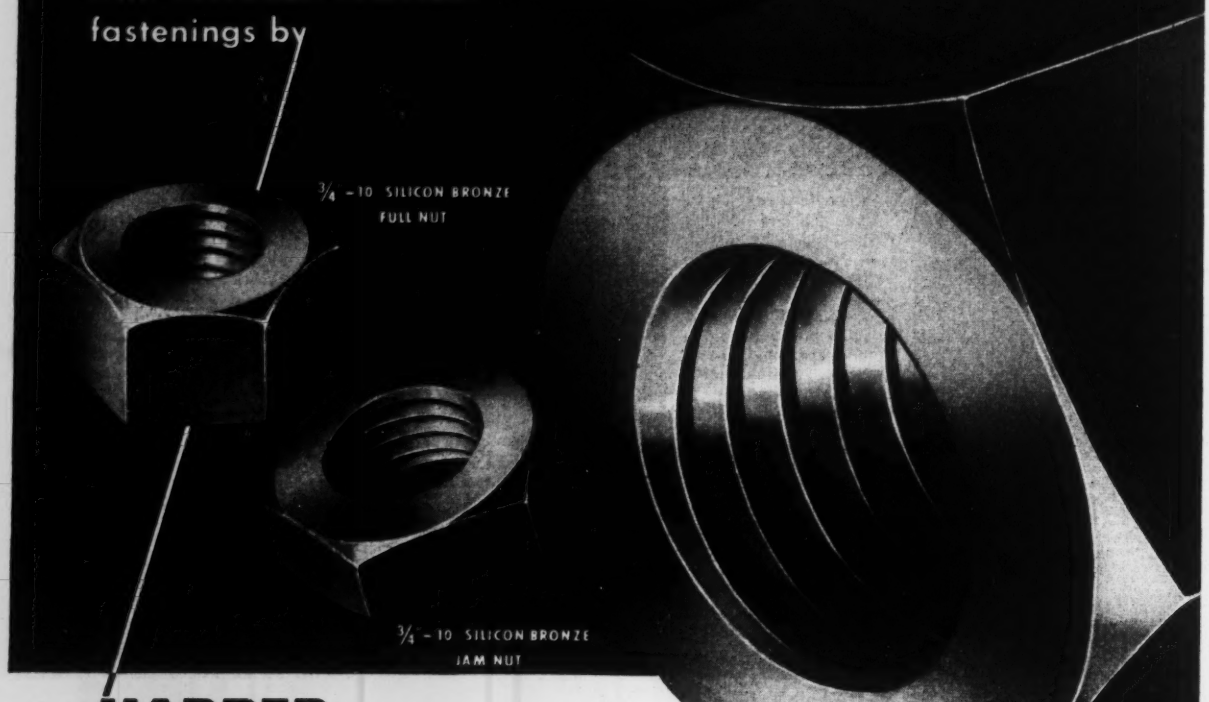
Company.....

Business Address.....

City..... Zone..... State.....

STOP CORROSION

with corrosion resistant fastenings by



HARPER

The cancer of corrosion is constantly at work, eating away the life of the equipment you manufacture. The H. M. Harper Company specializes in "Everlasting Fastenings" to combat corrosion. Bolts—nuts—screws—rivets—studs—washers of brass—naval bronze—silicon bronze—Monel—nickel—copper—aluminum—stainless steel—and the newer high temperature alloys.

Skilled engineers and metallurgists, backed by 30 years of experience, are available to work with you on the design and production of fastenings to solve the tough corrosion and assembly problems you may be facing.

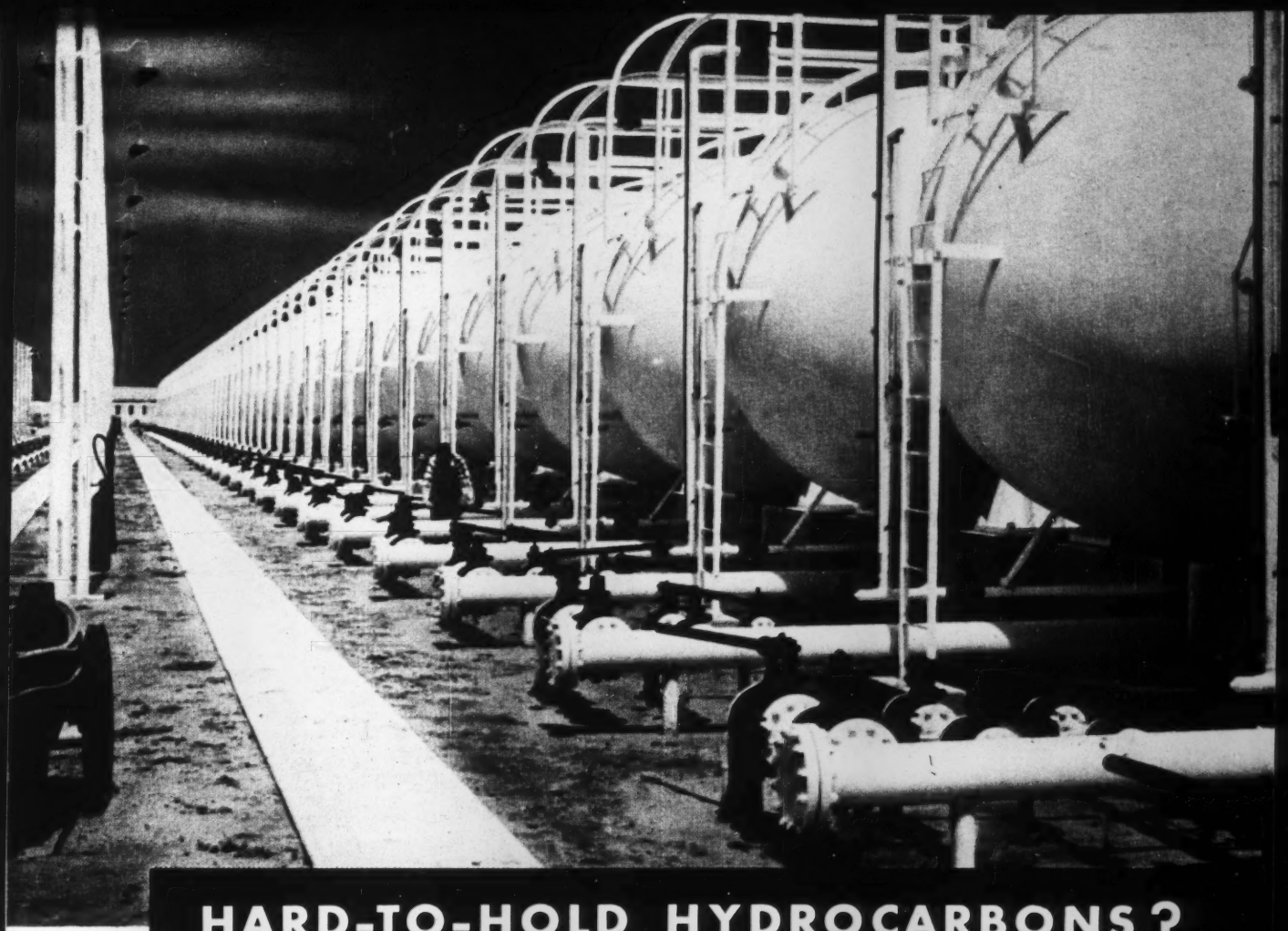
In every market area, you will find Harper Branch Offices and Distributors ready to give you prompt service. Over 7,000 items are carried in stock, making it possible for you to fill all your requirements from one source, bringing you these advantages—one order to write—one account to keep—one bill to pay.

THE H. M. HARPER COMPANY
8243 Lehigh Ave., Morton Grove, Ill.

HARPER
EVERLASTING FASTENINGS

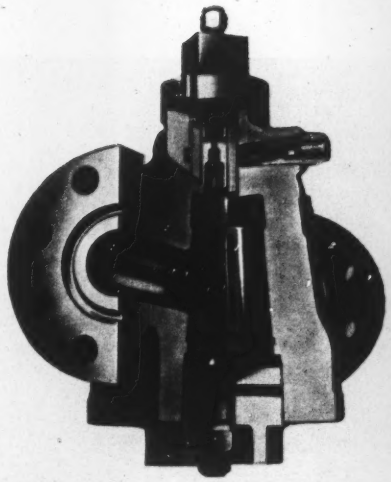
SPECIALISTS IN CORROSION RESISTANT FASTENINGS

BRASS • SILICON BRONZE • NAVAL BRONZE • MONEL • NICKEL • COPPER • ALUMINUM • STAINLESS STEEL



HARD-TO-HOLD HYDROCARBONS?
Nordstrom *LUBRICANT SEALS* Them

In this case, it's one of the world's largest butane and propane tank batteries that Nordstrom valves are controlling. But it might be any one of hundreds of volatile hard-to-hold hydrocarbons.

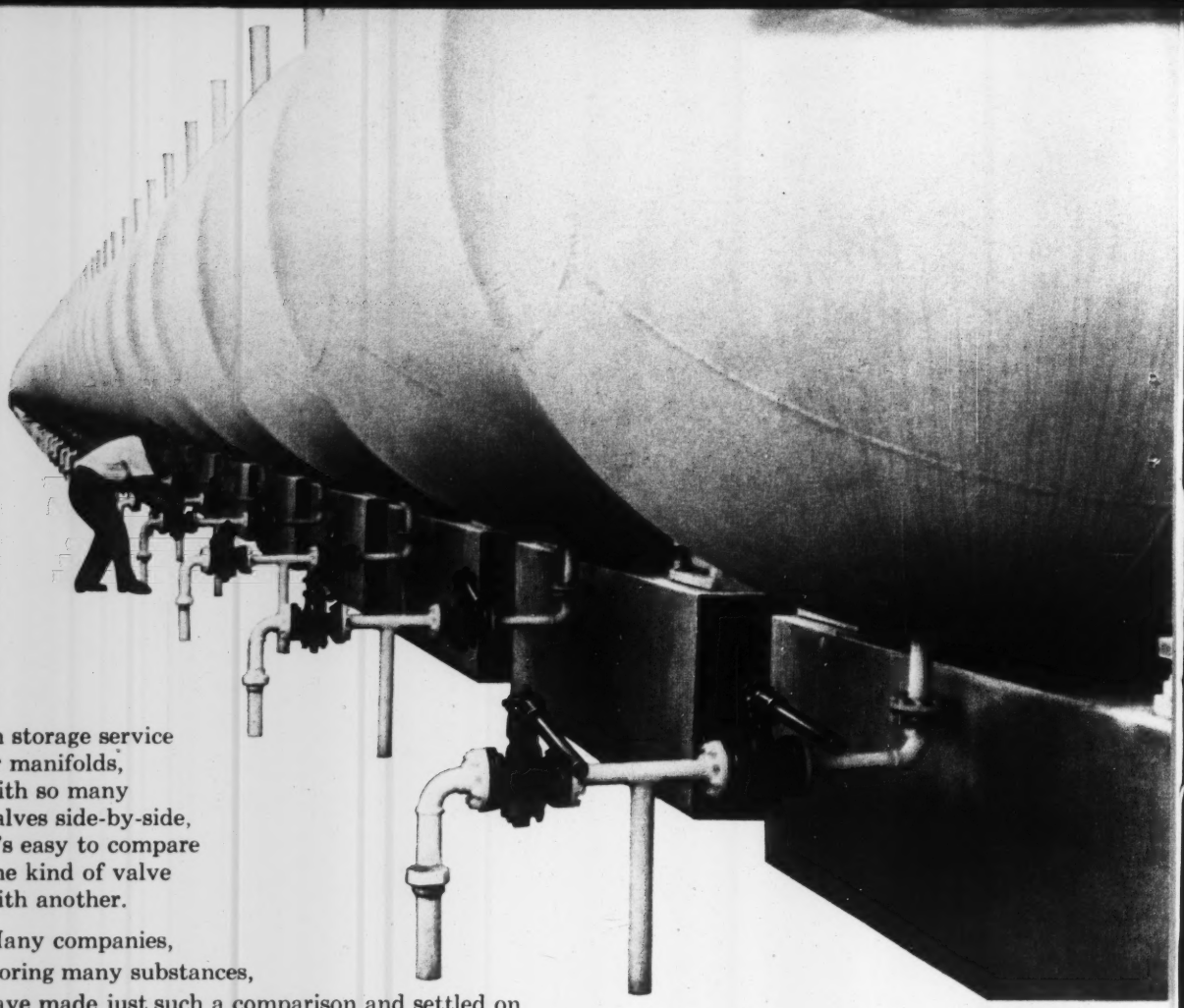


Nordstrom valves don't depend on metal-to-metal contact to check these light, tricky gases and fluids. Nordstrom valves have a seal of plastic lubricant around all seating surfaces—double protection against leaks of inflammable liquids or vapors.

Be sure—really sure. Use Nordstrom valves and genuine Rockwell lubricants. That's the *right* way—that's the *tight* way.
Rockwell Manufacturing Company,
Pittsburgh 8, Pa.

ROCKWELL Built
Nordstrom Valves
Lubricant-Sealed for Positive Shut-Off

Another ROCKWELL Product



In storage service
or manifolds,
with so many
valves side-by-side,
it's easy to compare
one kind of valve
with another.

Many companies,
storing many substances,
have made just such a comparison and settled on

NORDSTROM VALVES

Since Nordstrom valves are doubly sealed with an internal film of plastic lubricant, they are doubly protected against the little leaks that can become big dangers. Nordstrom valves operate quickly, too, for it takes only a quarter turn of the plug to change from fully open to fully closed.

AND ROCKWELL LUBRICANT

. . . the same lubricant that adds to valve tightness, acts as a jack to keep the plug ready to turn. Just as they cut costs in nearly every service to which they've been applied, Nordstrom valves and genuine Rockwell lubricants

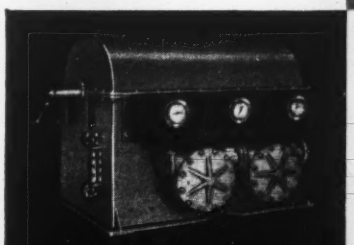
CUT STORAGE COSTS

Remember, the lowest cost valve is not necessarily the cheapest—
it is the valve which does its job best for the longest time.
Rockwell Manufacturing Company, Pittsburgh 8, Pa.

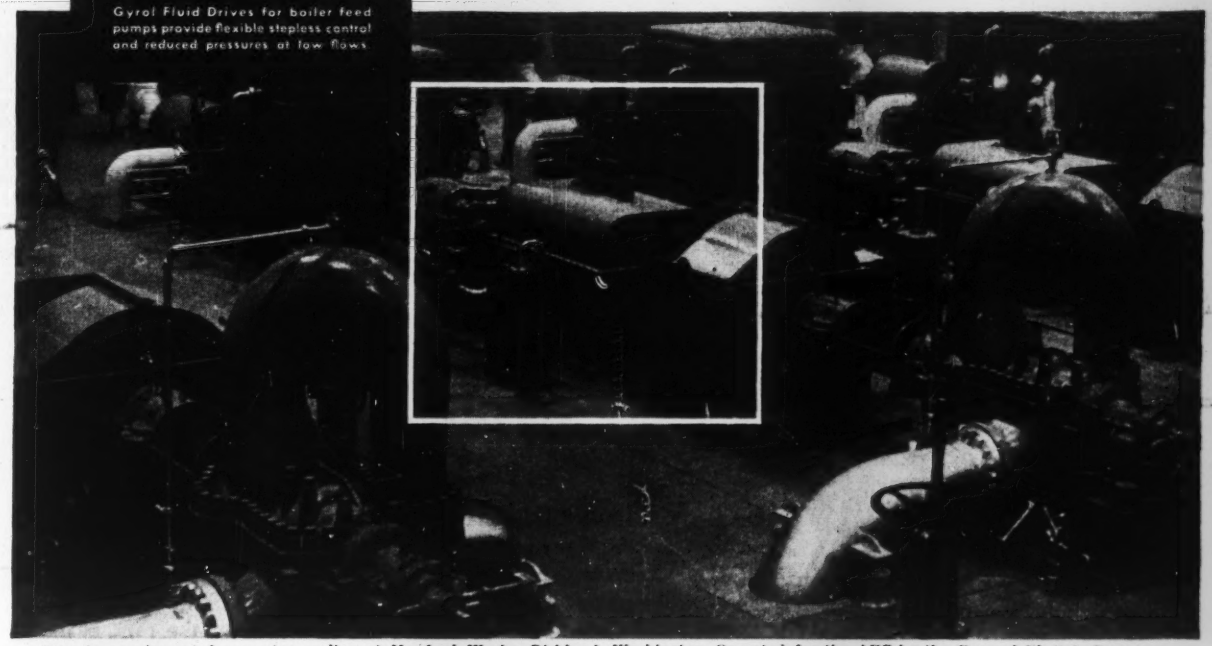
Nordstrom Valves Another Quality **ROCKWELL** Product

GYROL Fluid Drive

controls river of water to cool hot Plutonium



Gyrol Fluid Drives for boiler feed pumps provide flexible stepless control and reduced pressures at low flows



Pumping equipment for reactor cooling at Hanford Works, Richland, Washington. Operated for the AEC by the General Electric Company.

SO HIGH ARE THE TEMPERATURES around the nuclear reactors, or atomic "piles," that large, dependable, accurately and automatically controlled flows of pure high-pressure water are required for reactor cooling.

American Blower Gyrol Fluid Drive acts as the traffic cop for this mighty river of water. Remotely controlled, the fluid drive permits operation of the flywheel and feedwater pump at *variable* speeds (depending on water volume); also saves power by allowing the unit to start with the load disconnected.

This unique installation, first of its type in this country, is another example of American Blower leadership in power transmission.

If you require the benefits of lower starting current, smoother acceleration, overload protection and shock absorption on the equipment you buy or use, specify American Blower Gyrol Fluid Drives.

For complete data, contact the nearest American Blower Branch Office conveniently located in principal cities.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS

The new North American
FJ-2 carrier-based jet fighter

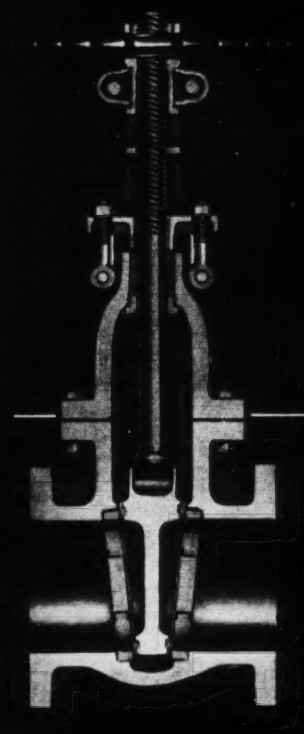
Production Teamwork puts the NAVY FURY in the Air!

AMONG the many specialists supplying component parts for the Navy's new "Fury" Jet Fighter is Parker White Metal Company. Parker Die Castings are used on the upper fuselage door access assembly, fuselage cooling duct system, fuel system, air fuel locks, air valves on intake ram, surface control system and as components of the highly classified gun-camera. Parker Die Castings are economical, strong and light weight. Machining is virtually eliminated, thus reducing costs. You will find Parker Die Castings highly practical from your point of view. Consult with Parker engineers on your next die casting requirements. Nearly a half century of experience is yours for the asking.

and when you think of Die Castings
THINK OF

Parker White-Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER ALUMINUM *and* ZINC *Die Castings*



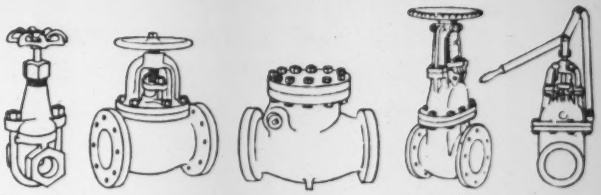
IRON

COMPLETE LINES OF IRON VALVES AND PIPE FITTINGS are manufactured by Walworth in a variety of types, pressure ratings, sizes, and patterns for general industrial use.

Walworth also manufactures complete lines of valves (including Lubricated Plug Valves), and pipe fittings made of steel, bronze, and special alloys.

These valves and pipe fittings, plus Walworth-made pipe wrenches total approximately 50,000 items and are sold through distributors in principal centers throughout the world.

Walworth engineers will be glad to help you with your problems. For further information call your local distributor, nearest Walworth sales office, or write to Walworth Company, General Offices, 60 East 42nd Street, New York 17, New York.



Iron valves in gate, globe, angle, check, and lubricated plug types are manufactured by Walworth. Illustrated is a sectional view of a Walworth No. 726F Standard Iron Body, Bronze Mounted, Wedge Gate Valve with flanged ends. This line of valves is available in sizes 2 to 30 inches. Similar valves of All-Iron type are also available.

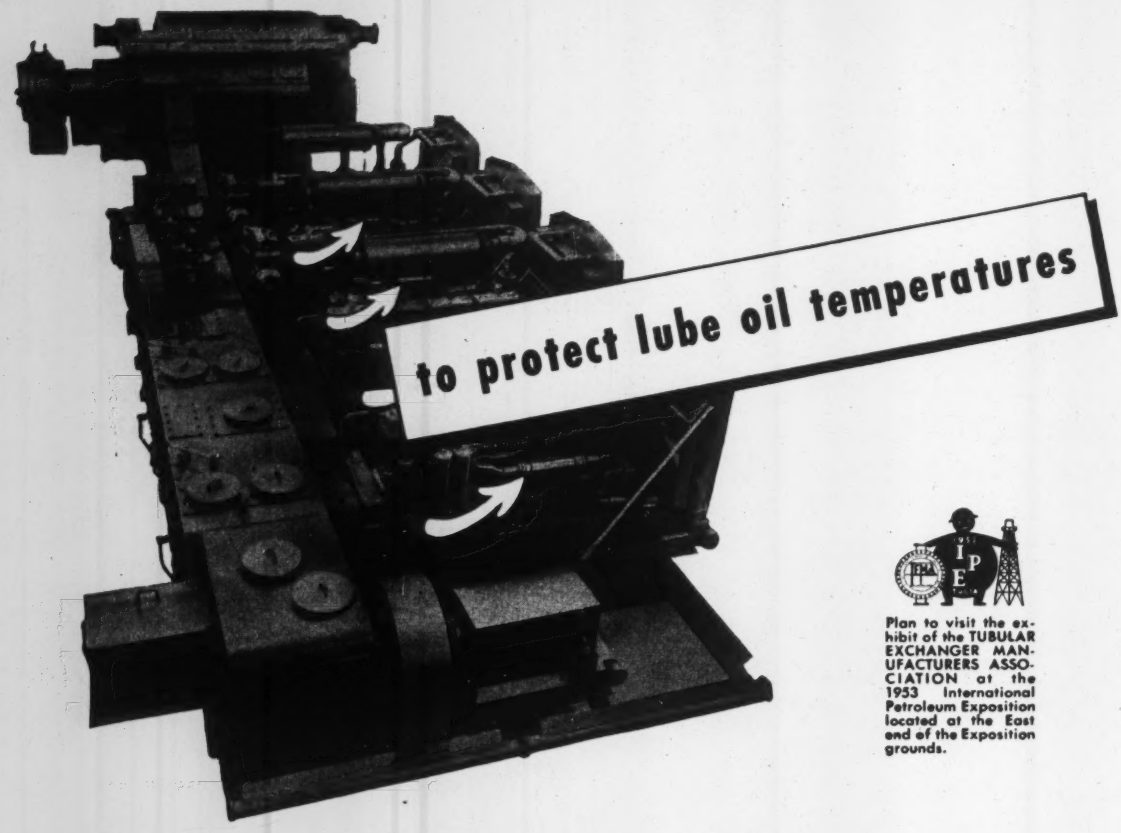
WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



Plan to visit the exhibit of the TUBULAR EXCHANGER MANUFACTURERS ASSOCIATION at the 1953 International Petroleum Exposition located at the East end of the Exposition grounds.

the 4 Buda engines powering this Brewster drawworks are ROSS EXCHANGER EQUIPPED

Fast at running a heavy string of pipe . . . powerful at the pump drives . . . and responsive to the demands of bit and rotary . . . this Brewster N-12 Drawworks can deliver the full might of its four 400 hp Buda engines on any one drilling operation or to any group of operations . . . *without risking overheated lube oil.* The Buda Company has equipped these engines with Ross Type BCF Exchangers.

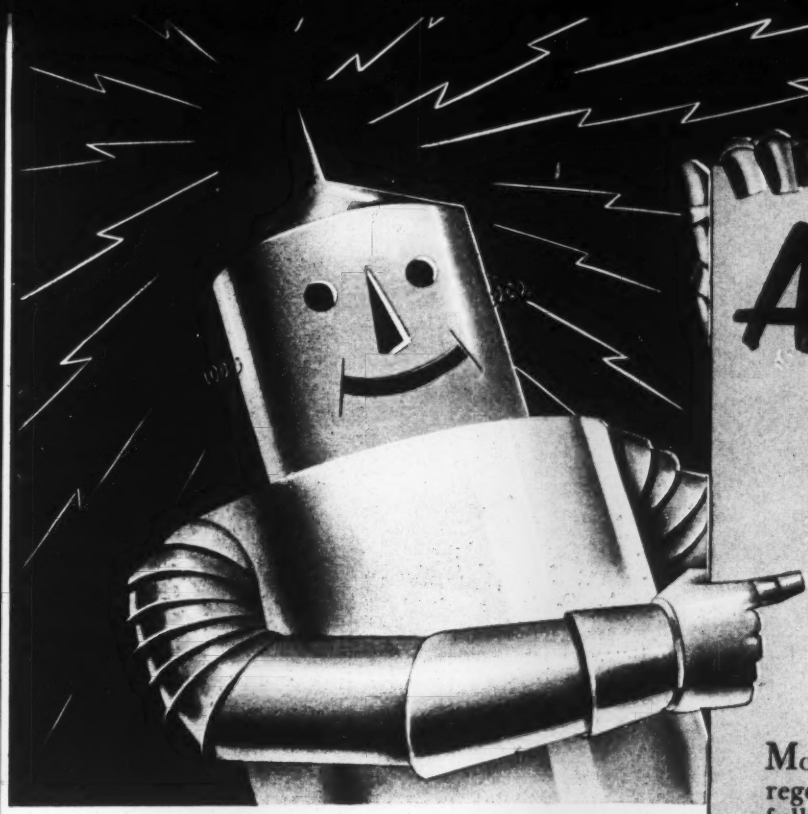
For years, top name engine builders, such as Buda, have factory installed dependable Ross Exchangers as standard equipment. They have found them to be the most positive way to insure engine life. Lube oil temperature is always under control!

Highly dependable and extremely rugged — Ross Type BCF Exchangers are used in virtually every segment of the gas and oil industry . . . oil fields, refineries, pipe lines, distribution. In fact, Ross Exchangers cross-cut practically *every industry* as lube oil coolers, jacket water coolers and in countless other cooling (or heating) applications.

Compact, enduring copper and copper alloy construction and pre-engineered, completely standardized designs have earned universal acceptance for Ross Type BCF Exchangers. Details are in Bulletin 1.1K5. Write.

KEWANEE-ROSS CORPORATION
DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION
1448 WEST AVENUE • BUFFALO 13, N. Y.
In Canada: Kewanee-Ross of Canada, Limited, Toronto 5, Ont.

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS



AUTOMATIC

Demineralization and Silica Removal by Ion Exchange Resins

MOTOR and diaphragm-operated valves make regeneration of Permutit Demineralizers fully automatic. This gives more positive control . . . eliminates the possibilities of costly errors . . . saves valuable man-hours formerly spent in regeneration.

In a recent installation for a 1450 psi boiler, two compact Permutit units fill all make-up requirements, regardless of changes in turbine loads . . . deliver a continuous supply of demineralized, silica-free water. What better way to eliminate scale and silica deposits!

HIGHEST PURITY MAKE-UP

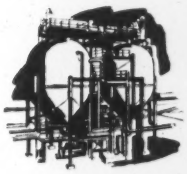
Effluents of Permutit Demineralizers have contained *total* electrolytes as low as 0.01 ppm and silica as low as 0.01 ppm! These values may be slightly higher under service conditions. In comparison, most distilled water contains 20 to 100 times more electrolytes . . . yet costs much more to produce.

INFORMATIVE NEW BULLETIN

You'll want this interesting book. Flow diagrams, illustrations and specifications explain key methods of demineralizing water and removing silica by ion exchange. Write for your copy, today!

THE PERMUTIT COMPANY, Dept. ME-5, 330 West 42nd Street, New York 36, N. Y., or the Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal, P. Q.

OTHER BASIC WATER CONDITIONING PROCESSES

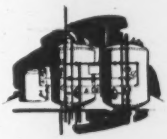


Sludge Blanket Hot Lime Soda

Full utilization of Permutit sludge-blanket principle assures high efficiency. Reduces hardness to region of 20 ppm . . . silica to 2.0 ppm. Lowers alkalinity . . . removes wide variety of solids.

Hot Zeolite—Permutit Q

Permutit Q—a styrene base resin resistant to high temperatures and pH values—replaces second stage phosphate treatment in hot-process softener. Results—residual hardness is completely removed at great savings in phosphate costs.

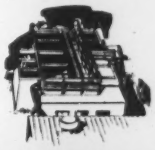


Deaerating Heater

Removes objectionable oxygen and CO_2 to prevent corrosion and pitting of feed lines, stage heaters, economizers, and boilers at high temperatures. Steam is used twice . . . deaerates water completely.

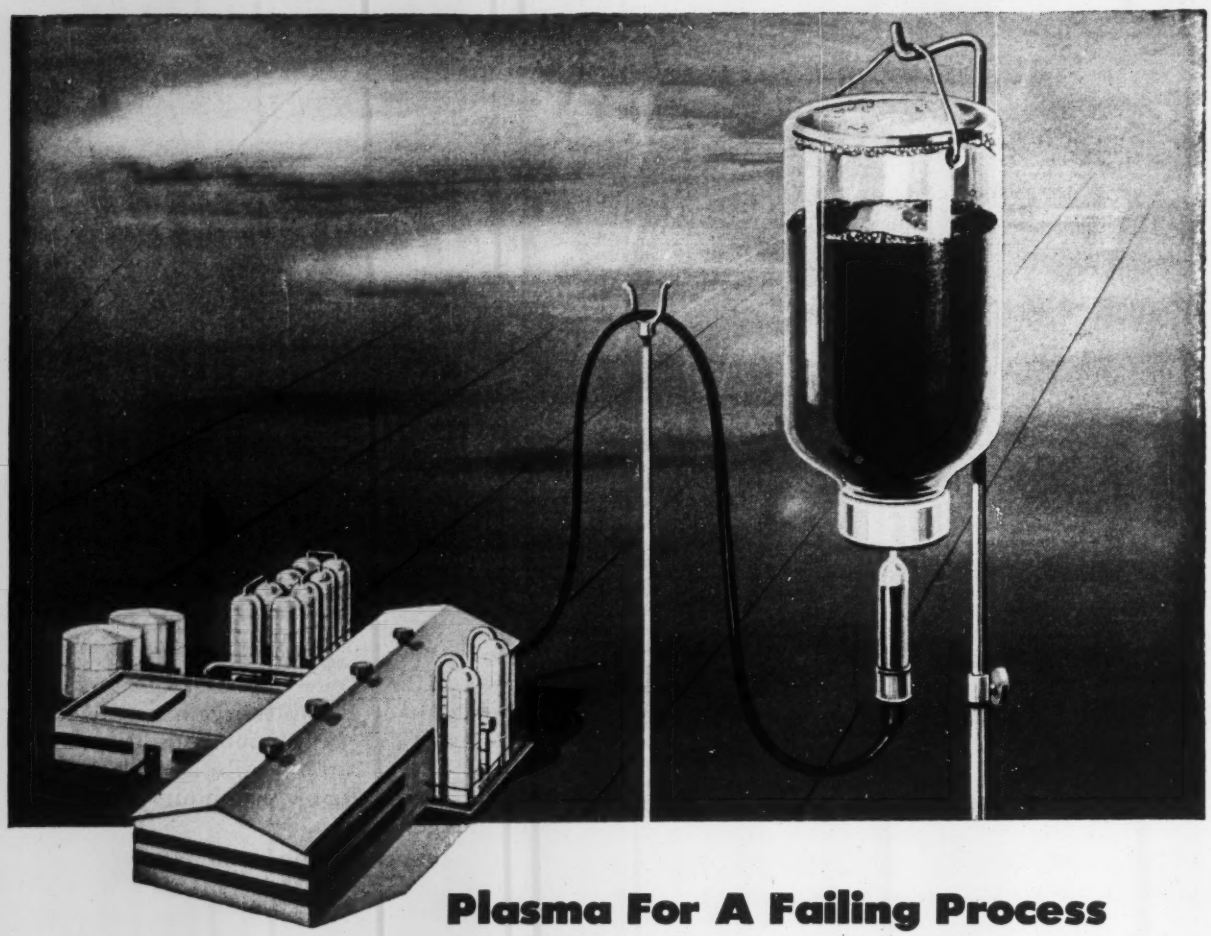
Precipitator

Softens water on space and time-saving sludge-blanket principle. Simultaneously removes turbidity, color, fluorides, reduces silica and lowers alkalinity.



PERMUTIT

ION EXCHANGE AND WATER CONDITIONING HEADQUARTERS FOR OVER 40 YEARS



Plasma For A Failing Process

Throughput usually suffers when any part of your process gets too weak to keep up with the rest of your system. Here's how one company we know prevented such a problem.

Chlorinated hydrocarbons for use in plastics had to be weighed. Test-tube accuracy without metallic pick-up, contamination or discoloration was essential. Stability had to be maintained with sub-zero temperatures.

The answer: jacketed weigh tanks on suspended scales. Passage between shells gave ample circulation for coolant, while a nickel-clad steel inner shell assured purity... fast, uniform heat transfer. Other results: easy low-cost maintenance, long life.

Where did this solution come from? It was the result of cooperative development between the engineering staffs of progressive Equipment Builders, process engineers and materials suppliers. In developing such equipment, these *better* builders regularly turn to Lukens for its knowledge of materials, as well as its wide range of low-cost clad steels.

Even with new equipment hard to get, these builders can often recondition what you have for better, more profitable production. For their names, write us today, explaining your problem. Manager, Marketing Service, 402 Lukens Building, Coatesville, Pennsylvania.

LUKENS

World's Leading Producer of

SPECIALTY STEEL PLATE · PLATE SHAPES · HEADS · CLAD STEELS

LUKENS STEEL COMPANY, COATESVILLE, PA.

In the almost quarter century that we have been in business, we have been called upon to develop and produce many highly specialized types of expansion joints. None, however, have been more spectacular than the 109-inch joints recently developed for use in testing equipment for aircraft engine prototypes. These low pressure joints were designed with a hundred internal tie bars, which permit the joints to absorb the lateral deflection between a long exhaust header, operating at 650° F. and a series of large gas coolers, without the need for heavy anchors. Eight of these joints are now in service in a classified defense project.

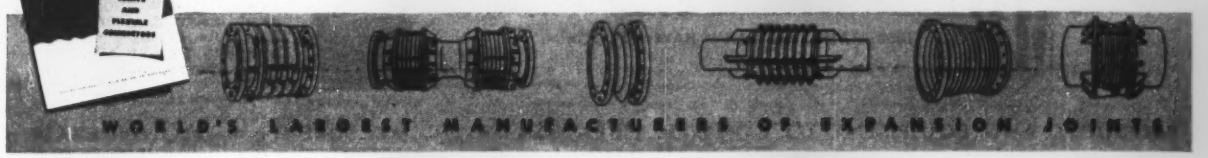
This is just another example of how Zallea engineers, with the experience gained from specializing in one product—expansion joints, are able to successfully and economically solve the most difficult problems confronting this type of industry.

But this is not all—we regularly manufacture a complete line of expansion joints capable of service in virtually any type of expansion application. These joints are available in diameters from 3 inches to 30 feet for temperatures from sub-zero to 1600° F. . . . for pressures from vacuum to 300 psi in standard designs and up to 2,000 psi in special designs.

For full details regarding your expansion joint problems or requirements, just get in touch with us. Zallea Brothers, 820 Locust Street, Wilmington 99, Delaware.

For detailed information on Zallea Expansion Joints and services write today for a free copy of Bulletin 351.

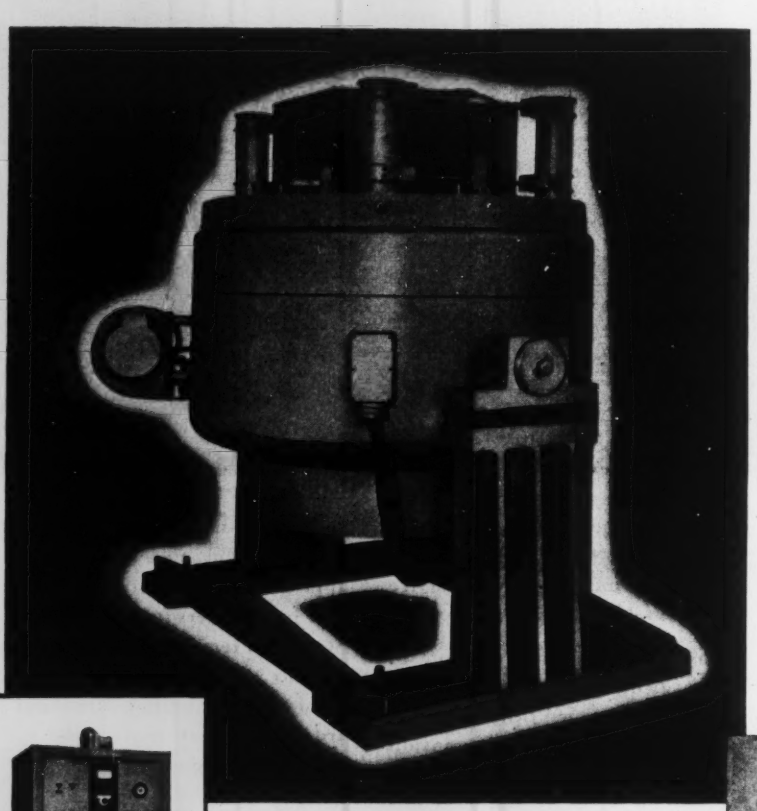
Zallea
EXPANSION JOINTS



Largest Vibration Exciter Ever Built

▶ *New MB shaker delivers 10,000 pounds force output!*

▶ *Widens scope of vibration testing to MIL-E-5272 and other specifications!*



HERE's the latest—and the *largest* – vibration exciter ever built for shake testing. Developed by MB vibration specialists, this unit incorporates all the advances made in the last seven years for assuring dependable operation, pure table motion, and absence of resonances. These include specially designed table flexures, forced air cooling, built in protection against overtravel of the table and against misoperation of the equipment.

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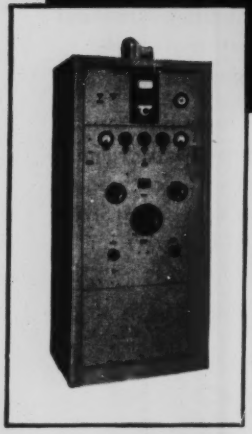
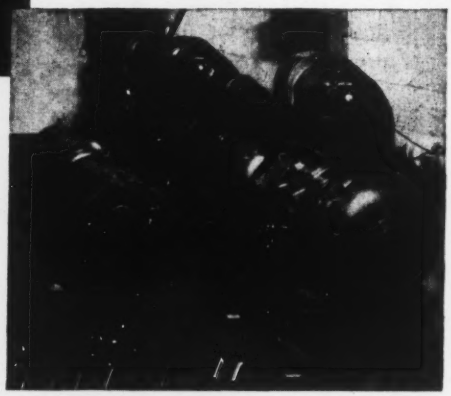


MODEL C-100 VIBRATION EXCITER has ½" total table travel. Flexure design supports heavy table loads without sacrificing stroke. Trunnion support permits operation in all positions from horizontal to vertical, and has built-in vibration isolation. Operating range: 5 to 500 cps.

CONTROL PANEL (Model T-100) assures proper operation of equipment with interlocked controls. Accurate, easy, continuous control of force and frequency permits quick adjustments, or "scanning" over entire operating range. MB Vibration Meter provided; also running time meter.

ROTATING POWER SUPPLY rated to deliver full power without need for power factor correction. Blowers cool each unit separately. Alternators feed driver coil of shaker, with minimum harmonic distortion.



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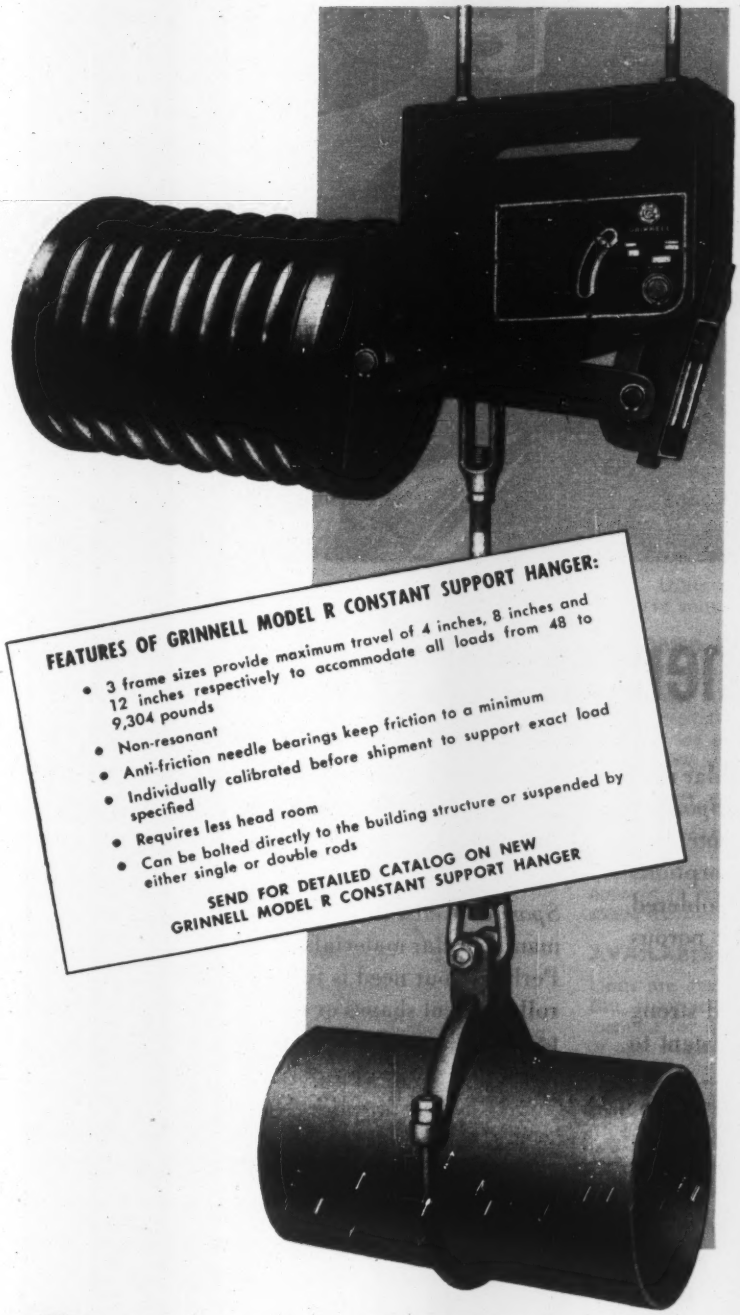
BULLETIN TELLS MORE
Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE-4.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO GENERATE IT

The New GRINNELL MODEL R CONSTANT SUPPORT HANGER



FEATURES OF GRINNELL MODEL R CONSTANT SUPPORT HANGER:

- 3 frame sizes provide maximum travel of 4 inches, 8 inches and 12 inches respectively to accommodate all loads from 48 to 9,304 pounds
- Non-resonant
- Anti-friction needle bearings keep friction to a minimum
- Individually calibrated before shipment to support exact load specified
- Requires less head room
- Can be bolted directly to the building structure or suspended by either single or double rods

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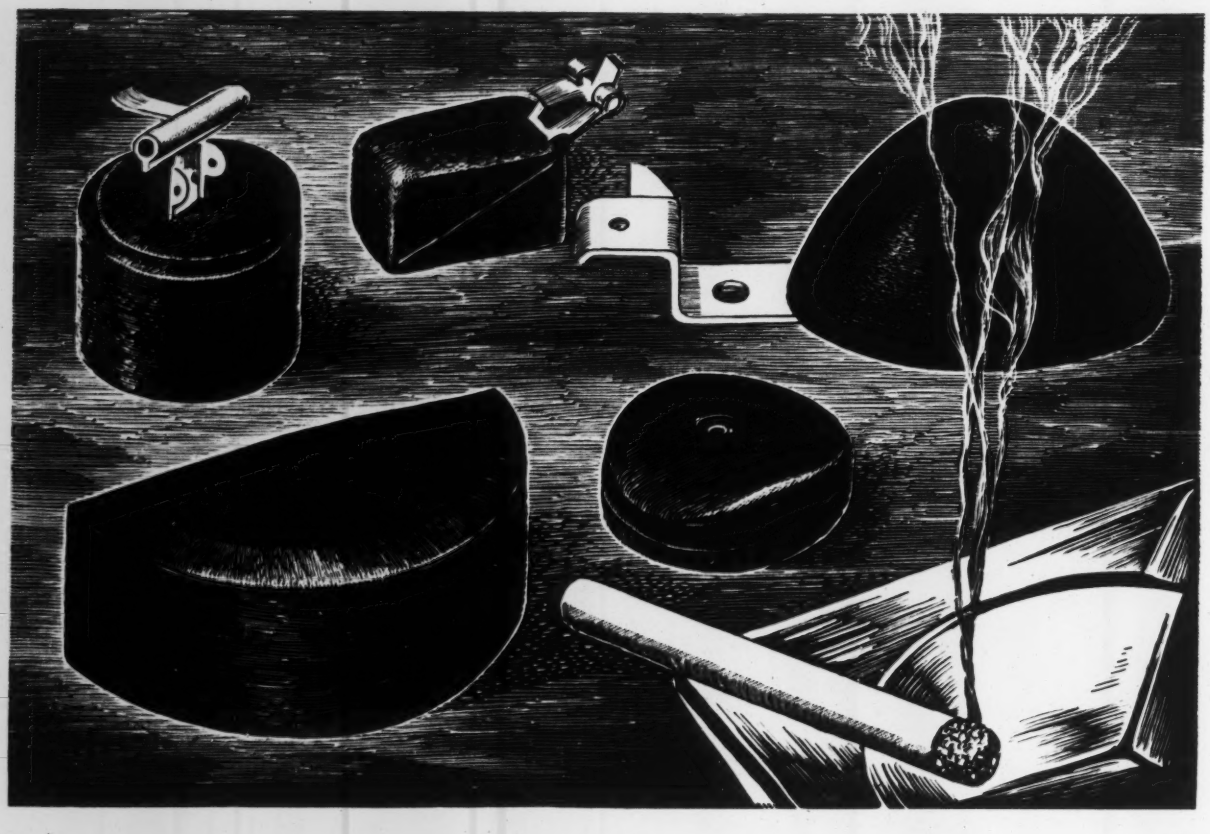

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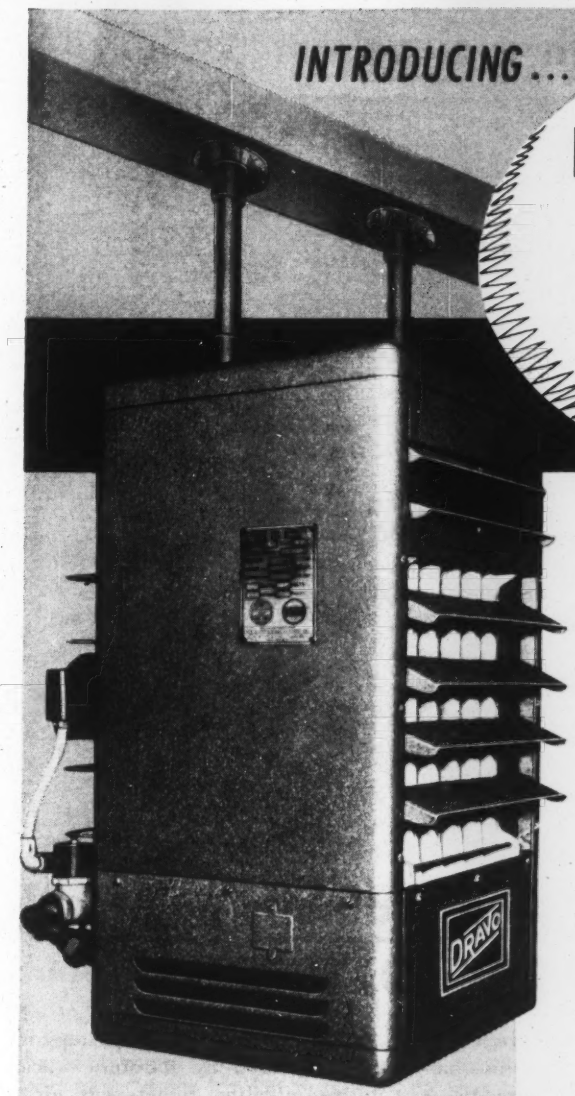
Suspended Type

UNIT HEATER

—for heating and ventilating commercial and industrial buildings

—for process drying



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The Dravo Gas-Fired Unit Heater is ruggedly constructed with a cast iron heat exchanger, cast iron burners and a heavy-gauge steel exterior jacket with baked enamel finish . . . all designed for years of satisfactory service.

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The Dravo Gas-Fired Unit Heater is delivered completely assembled. Installation requires only hooking up gas connection and exhaust stack. Units are wall-hung or suspended from roof trusses to conserve valuable floor space.

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AVAILABLE NOW

Units are available in a variety of sizes from 68,000 to 172,000 Btu, equipped with a fan or blower. Blower models are recommended for installations requiring heated air at greater velocity or against greater static pressure.

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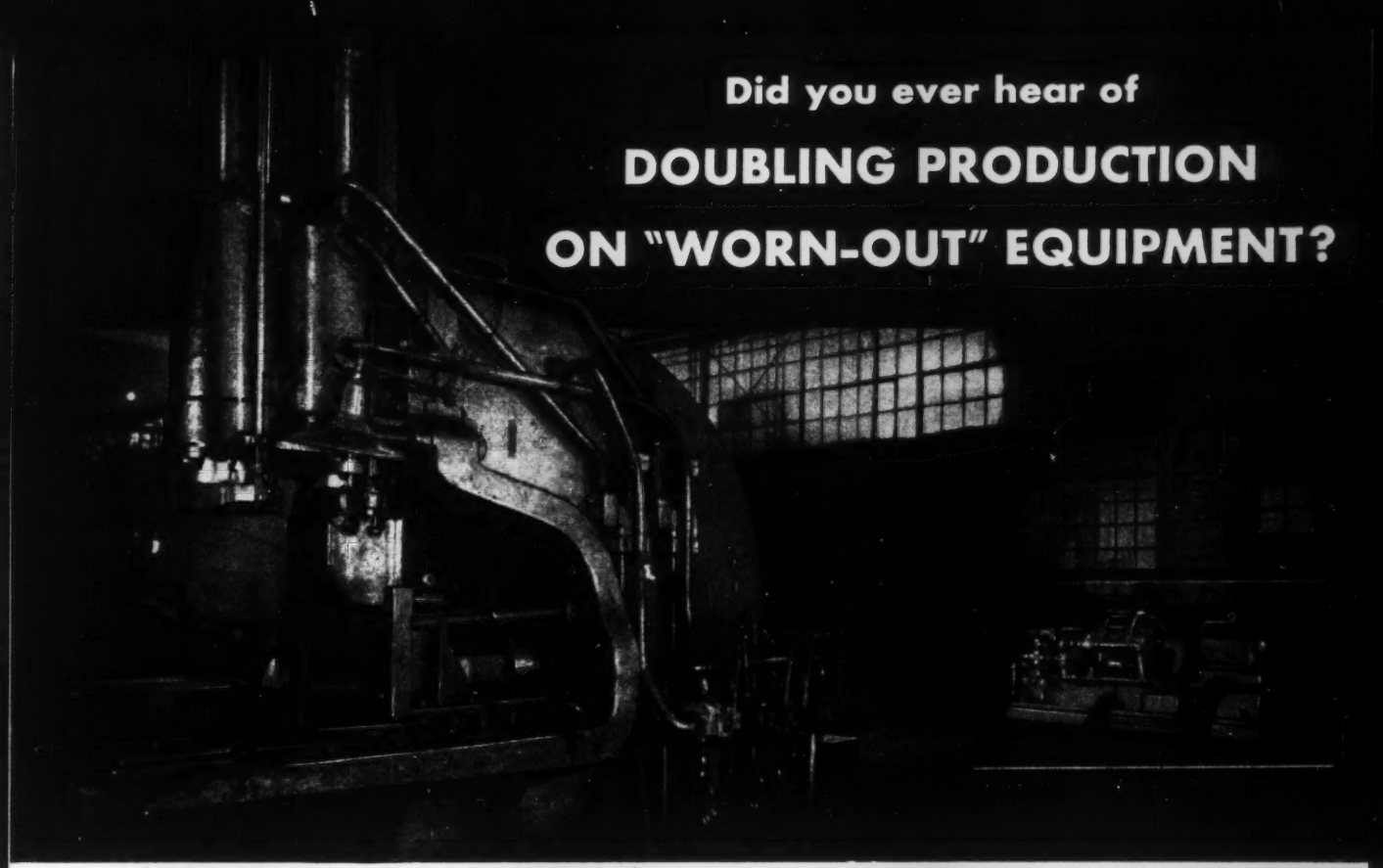

Did you ever hear of DOUBLING PRODUCTION ON "WORN-OUT" EQUIPMENT?

You may gain a valuable hint from this story how Treadwell renovated an old belling machine with Oilgear Fluid Power

The belling machine used for flanging big boiler ends in the Treadwell Corporation plant at Midland, Pa., has seen many years of service. The machine was slow, was "down" a lot, maintenance was high and production was off.

A careful analysis indicated that the press itself was not at fault; the trouble was associated entirely with the water pump, storage and accumulator system used to power the press gripping and main rams.

Two alternatives confronted the Treadwell people. One was to repair or replace the water system. This ran into a figure prohibitively high. It would not solve the problem of high maintenance, faulty control, erratic performance, the shocks inherent in the system, the slow cycles.

The Treadwell people chose the second alternative and called in an Oilgear Fluid Power engineering representative. This is what happened:

A standard Oilgear Fluid Power system was installed, without modification to the press. The only change was some rearrangement of the piping system. The cost was from one-fourth to one-third that of repair to or replacement of the water power system.

The operation of the rams was speeded up, the total time for each cycle cut from 66 seconds to 34 seconds. Therefore actual press production was almost doubled. Because the power medium used is oil, friction and wear become almost non-existent. The space required is slightly less than that required by the water pump, but the bulky water tank and accumulator were eliminated altogether.

The interesting thing about this Oilgear Fluid Power, which is smooth, shockfree and dependable is that from the one source, power travels to actuate the gripping rams, then while holding them at gripping pressure, travels over to the main or shaping ram and actuates it; then the same power retracts the rams in order and goes into "neutral" during the next handling step.

The above is only one of a number of similar press "renovations" being performed with the use of Oilgear Fluid Power.

Think of Oilgear Fluid Power as similar in every respect to electric power. It is generated, piped, and applied in the same way, with these **important** exceptions: Oilgear Fluid Power can be used in linear movement where electricity cannot. Oilgear Fluid Power speed can be varied steplessly, smoothly, infinitely where electricity cannot — or only with costly, troublesome, **extra** equipment. Oilgear Fluid Power can be "bled" off, dissipated harmlessly in case of shock. Oilgear is massive, tremendous, resistless power that can be controlled with micrometer precision.

It is probably the most amazingly versatile power there is. Consider Oilgear Fluid Power to improve the saleability of new machines, to renovate old machines, to solve a hundred troublesome problems where other power has failed to help. It costs you nothing to find out. THE OILGEAR CO., 1570 W. Pierce St., Milwaukee 4, Wis.

OILGEAR

OILGEAR

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It takes a "department store" of chain to meet industry's conveying and drive needs

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YES, men of industry have learned they find a virtual "department store" of chain available through Link-Belt plants, distributors and factory branch stores. They know they can get the *right* chain for their exact requirements from the complete Link-Belt line.

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Chain for drives and conveyors is but one of the many products offered by Link-Belt. In fact, wherever materials must be moved or power transmitted, you'll find Link-Belt equipment at work helping industry meet its goal.

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ONE SOURCE . . . ONE RESPONSIBILITY FOR MATERIALS HANDLING AND POWER TRANSMISSION MACHINERY

HERE'S HELP IN SCRUBBING GASES OR FUMES

If gases or fumes are a plant problem or if you must satisfy local ordinances regarding air pollution, you will be interested in two types of Gas Scrubbers manufactured by SK.

Both consist of a scrubber box, SK Spray Nozzles, and SK Throat Pieces. The box, which encloses the components, is divided into "banks" as shown in Fig. 4031.

The Fig. 4030 Scrubber is a system rather than a unit since SK supplies the spray nozzles and throat pieces and the customer builds the box from sheet metal, cement, wood, or other material which fits his needs.

The Fig. 4031 Scrubber, illustrated, is a "packaged" unit which includes an integral separator for separating spray liquid after scrubbing.

Both operate on the same principle to handle and wash gases of varying types. As gas enters each bank, it is entrained and forced through the throat pieces into succeeding banks by the spray action of the liquid from the nozzles. High scrubbing efficiency, as much as 98 to 99-plus per cent, can be realized since gas cannot by-pass the spray and thorough mixing occurs. Fig. 4031 illustrates this operation. The number of nozzles, throat pieces, and banks are determined by the volume and characteristics of the gas and the efficiency desired.

Illustration, Fig. 4030-A, shows a system employing an SK Fig. 4030 Gas Scrubber in use at Ehret Magnesia Manufacturing Co.'s new plant at Valley Forge, Pa. This system is being used to wash and cool carbon dioxide gases from oil-fired boilers for later use in the company's magnesia carbonation process.

Complete information on SK Gas Scrubbers is contained in new Bulletin Supplement 4-RA. Request a copy.

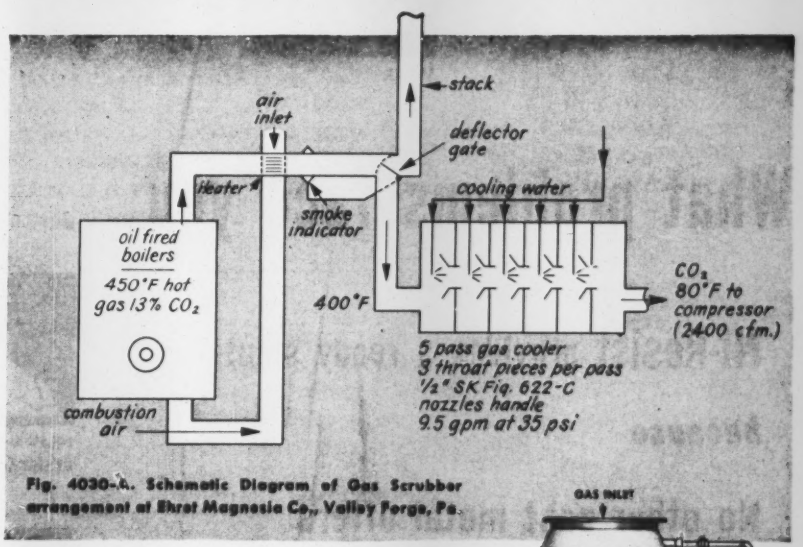


Fig. 4030-A. Schematic Diagram of Gas Scrubber arrangement at Ehret Magnesia Co., Valley Forge, Pa.

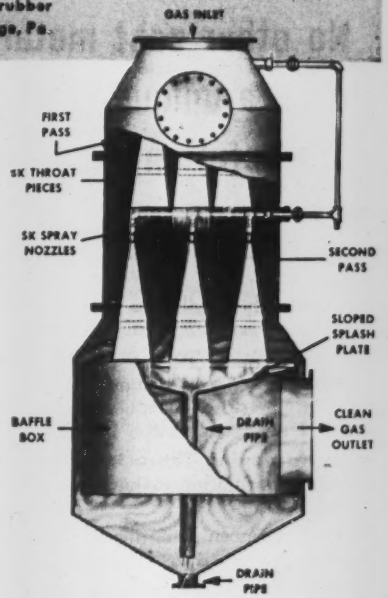
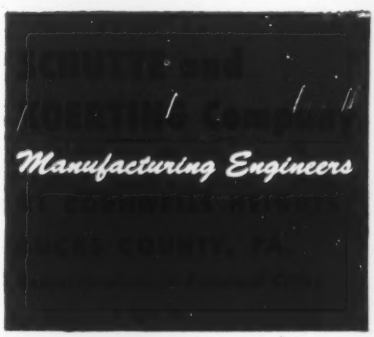


FIG. 4031. SK "Packaged" Gas Scrubber Unit

SK Rotameters are simple, accurate and convenient rate of flow measuring devices designed and built in a variety of types and sizes for diverse applications. Bulletin 18-RA pictures and briefly describes all types of SK Rotameters and lists, by number, the detailed bulletin relating to each. Send for your copy of Bulletin 18-RA today.



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Use Ni-Resist® for a specific need or a combination of requirements.

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

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Bell-Type Annealer for Accurately Controlling Alloy Grain Size

(Inner steel hood is lowered by crane over coils of strip brass stacked on platform of bell-type annealing furnace at Chase Brass and Copper Company mill at Waterbury, Conn. When inner hood is in place and lowered into an oil seal the gas-fired heating furnace, background, is then lowered over the whole assembly.)

VOLUME 75
No. 5

MECHANICAL ENGINEERING

MAY
1953

GEORGE A. STETSON, *Editor*

ASME Lubrication Activity

THROUGHOUT the history of ASME the subject of lubrication has been discussed at meetings and in papers published by the Society. Practically every phase of the subject has been the concern of members working in research, in the theory of lubrication, in design, in the properties of lubricants, in the operation and maintenance of all kinds of machinery, in the specialized problems of major categories of machines, in antifriction bearings, and in other cases. Special committees organized under the Professional Divisions and the Research Committee have existed simultaneously and sometimes have operated quite independently of one another. More recently an attempt at co-ordination has been made in the organization, on what is said quite frankly to be an experimental basis, of a group known as the ASME Lubrication Activity.

As currently organized the Lubrication Activity consists of six existing groups and one in process of formation. These groups are:

Research, which concerns itself with lubrication theory, the mathematical treatment of design, and investigations of boundary and fluid-film phenomena.

Lubricants, which covers physical properties and action of lubricants.

Design features of machines, including bearings, gears, cylinders, and similar machine elements involved in the lubrication problem.

Builders' problems, such as reservoir design, seals, lubrication systems, methods of starting new machines, and maintenance as related to construction.

Operators' maintenance practice, overhauling, and repair methods, management, organization, and personnel of lubrication plant and operations.

Co-ordination of the work of the Lubrication Activity with ASME Professional Divisions and other engineering societies.

Application, a group yet to be organized to deal with application methods, equipment, filters, and purifiers.

Each of the foregoing primary groups is represented on the Executive Committee of the Lubrication Activity in order that complete co-ordination may be realized. In consequence, not only are the securing and handling of papers for presentation at meetings co-ordinated, but the procurement of interested, trained, and experienced persons necessary for carrying forward specific projects is expedited.

A number of projects have already been started by the Lubrication Activity. These include study of the catalytic effect of materials on lubricants and the effect of lubricants on metals; investigation of the proper paints for metal surfaces in contact with oils; rolling-element bearings; sliding bearings; plant training of lubrication personnel; organization of plant lubrication departments; co-ordination of lubrication design data; and fretting corrosion.

Plans are being perfected by the Lubrication Activity to render special services to ASME Sections. It is hoped that a number of "package programs" can be organized so that a Section which desires to stage a session on lubrication will have available to it the package program which will best suit its needs. The Lubrication Activity will provide speakers competent to handle such programs.

Co-operation with ASME Professional Divisions is being initiated with the Heat Transfer Division in a co-sponsored project on heat transfer in bearings and gears.

Relationships have already been established with the American Society for Testing Materials and the American Society of Lubrication Engineers. Other inter-society relationships will be established as required.

The interest and support of one hundred and fifty registered members which constitute the present nucleus of the ASME Lubrication Activity should attract additional workers as organization is put on a firm footing and programs are developed. This nucleus, which welcomes recruits who should specify the primary groups of the Lubrication Activity's program in which their major interests lie, is intent on carrying forward the great tradition which ASME has long since established in adding to the mechanical engineer's store of knowledge of an important all-inclusive subject. Not only will the specialists in the numerous branches of this field of engineering benefit by an interchange of newly formalized knowledge and practical experience, but all engineers whose lubrication problems are incidental to their own major specialities will find a rich source of information and aid in the service elements of the Lubrication Activity's program.

Lubrication an Old Problem

TO THE younger generation of engineers it sometimes comes as a shock to learn of the long hard struggle that engineering has traveled in emerging from the empiricism of the mechanic arts and developing a sound scientific basis for the fundamental principles upon which so much of modern theory and practice are based. And most of us are still amazed when we realize that, extensive as progress has been, there still remain

to be solved countless problems that appear to grow in number in proportion to our increase in knowledge. In lubrication, for example, formulation of the ASME Lubrication Activity calls to mind the fact that the introduction of power-driven machinery by Arkwright and of the steam engine by Watt emphasized the importance of lubrication in the machine age and stimulated advances made through the development of a prodigious number of special oils for special uses, and through a better understanding of the theory on which the design of bearings is based.

In "Directions for Erecting and Working the Newly Invented Steam Engines," issued in 1779 by Boulton and Watt, the state of the art of lubrication is revealed by this simple paragraph:

"The proper grease for the piston and cylinder stuffing box is melted tallow, and for the chains, gudgeons, &c. common Spanish olive oil (called Sallet oil) which for some uses may be thickened by dissolving some tallow or butter in it, by means of heat.—Lintseed oil should never be used as grease, as it dries and creates more friction than would have been without it.—Hogs lard, or train oil, if applied any where about the cylinder, or where it is hot, will thicken like lintseed oil.—When the oil or grease about the great chains, or any of the working parts grows clotted or very thick, it should be scraped off before new grease is added." Under "additional directions" it is further stated: "The proper quantity of tallow to grease the piston, is two pounds every week for every foot the cylinder is in diameter."

The great oscillating beam of the Watt engine was built with gudgeons supported on plummer blocks fitted with brasses, like an inverted railway journal bearing. Watt wrote: "The rounded part of our cast-iron gudgeons is about 12 inches long and six inches dia'r.; not to increase the strength . . . . but to give a greater bearing, for if a great weight is laid upon a small gudgeon it will inevitably tear the brass it works in. As to the friction, that is lessened by contriving it so that the brass stands always full of oil."

Here we have the substance of the art of bearing design and lubrication as applied to heavy machinery in the early days of the Industrial Revolution.

A standard book of reference, "Appleton's Dictionary of Machines, Mechanics, Engine Work, and Engineering," published 100 years ago, mentions none but oils of animal or vegetable origin and classifies them as fixed and volatile oils. It states: "The most valuable quality in an oil intended for the lubrication of machinery is *permanent fluidity*. That oil which will for the greatest length of time remain fluid in contact with iron or brass is, without doubt, the most useful for its purpose." It describes also Naysmith's oil test in which various kinds of oil are permitted to run in grooves in an inclined iron plate. "The several oils make a fair start in their race down hill; some get ahead the first day, and some keep ahead the second and third day, but on the fourth or fifth day the truth begins to come out; the bad oils . . . . . come soon to a standstill by their gradual coagulation while the good oil holds on its course; and at the end of eight or ten days there is no doubt left as to which is the best . . ." The article ends with the observation: "For nice machinery nothing has been found to equal the *best* spermaceti oil, and it is a mistaken economy which applies inferior oil to good machinery."

In 1862, according to Capt. E. C. Smith, investigations by eminent chemists on behalf of the Peninsular and Oriental Steam Navigation Company resulted in recommendations that "for the internal lubrication of engines, tallow and vegetable and animal oils should be replaced by mineral oils."

By the time C. J. H. Woodbury of Boston, presented his paper "Measurements of the Friction of Lubricating Oils," at the first Annual Meeting of The American Society of Mechanical Engineers, engineers had adopted the scientist's method of controlled experiments with thoughtfully designed equipment and observational techniques, all of which he described. The oils he tested included those of mineral as well as animal and vegetable origin, and the results are presented in numerous curves and tables. Woodbury recognized that the friction characteristic of the oil was but one of many factors to be considered in the problem of lubrication. "The lubricant is one of the most important factors in the cost of power," he stated, and "in a print cloth mill only about twenty five per cent of the power is utilized in the actual processes of carding, spinning, and weaving the fibre, not including the machinery engaged in the operation, leaving seventy five per cent of the power as absorbed by the rigidity of belts, the resistance of the air, and friction. . . . Oils with great endurance are apt to give great frictional resistance, and in the endeavor to save *gallons* of oil, many a manager has wasted *tons* of coal. The true solution of solving the problem of lubricating the machinery of an establishment is to ascertain the consumption of oil, and the expenditure of power, both being measured by the same unit, viz., dollars."

Three years after Woodbury presented his ASME paper, Beauchamp Tower reported to The Institution of Mechanical Engineers the results of his experiments with railway bearings in which he recognized the importance of the wedge-shaped film of oil that exists between the shaft and its bearing. Following up the lead Tower had given him, Osborne Reynolds, in 1886, developed the hydrodynamical theory of lubrication on which all subsequent work on the design of bearings and the theory of lubrication has been based. In the early years of the present century this theory was further extended to include thrust bearings in the work done simultaneously and independently by Albert Kingsbury, Honorary Member ASME, and A. G. M. Michell of Australia. Later the Kingsbury or Michell pivoted-pad bearing was extended to apply also to cylindrical journals, and a recent analysis of that phase of the subject is to be found in this current number of MECHANICAL ENGINEERING.

It is hoped that the foregoing incomplete and hasty review of some steps in the development of lubrication from the days of Watt will serve to stimulate reflection on the long road engineers have traveled, and are still traveling, in a field which involves every branch of mechanical engineering and every piece of machinery, no matter how small or how large.

NUCLEAR POWER PLANTS

Design and Performance of Liquid-Metal Heat Exchangers and Steam Generators

By R. D. BROOKS[1] AND A. L. ROSENBLATT[2]

KNOLLS ATOMIC POWER LABORATORY,[3] SCHENECTADY, N. Y.

NOMENCLATURE

The following nomenclature is used in the paper:

A = heat-transfer area, sq ft
h = film heat-transfer coefficient, Btu/hr sq ft
K = thermal conductivity, Btu/hr sq ft deg F/ft
Q = heat flow, Btu/hr
U = over-all heat-transfer coefficient, Btu/hr sq ft deg F
θ = log mean temperature difference, deg F
N_{Nu} = Nusselt number
N_{Pr} = Prandtl number
N_{Re} = Reynolds number
N_{Pe} = Peclet number

Subscripts:

i = based on inside diameter, inner tube
o = based on outside diameter, outer tube
1 = based on inside diameter, outer tube
2 = based on outside diameter, inner tube

INTRODUCTION

Design considerations have indicated liquid-metal coolants to be quite promising for use with the nuclear-energy sources to produce power. Preliminary investigations of the factors involved proved that sodium and NaK were quite favorable for use even to temperatures of 1500 F. However, the reaction of alkali metals and water releases such quantities of energy as to require the design of equipment in which the possibility of mixing is reduced to the magnitude of normal engineering risk. For this purpose, heat-exchange equipment was developed having two integral fluid paths separated by a third buffer fluid. This third fluid reacts with neither of the two heat-exchange liquids and serves as a leak detector for the exchanger. This type of construction introduces an appreciable additional thermal resistance to the exchanger, but, in view of the hazard involved, was considered necessary. For the steam generators, mercury was chosen as the third fluid. An additional barrier between the nuclear source and the steam generator was provided by means of an intermediate heat exchanger. This was a liquid metal-to-liquid metal heat exchanger which used sodium as the intermediate fluid. A more detailed description of heat-transfer-system requirements is given in a paper by T. Trocki and D. B. Nelson (1).[4]

HEAT EXCHANGERS

Flat-Tube Heat Exchanger. A number of configurations of three fluid units were investigated in an attempt to find a minimum volume exchanger. There were several major items which contributed to the size of units:

1 Heat-transfer coefficient should be high to give minimum heat-transfer area.

2 Heat-transfer surface arrangement should be compact to give minimum volume without excessive pressure drop.

3 Header design should require minimum volume.

The most satisfactory unit that complied with the design requirements and was capable of being fabricated with available methods was a design involving flattened, hockey-stick-shaped tubes. This unit was built by the Foster Wheeler Corporation. The tubes were installed in alternate layers for the hot and cold fluids, giving the effect of a symmetrical flat-plate heat-transfer configuration. The flat-tube construction gave a very compact arrangement with relatively high heat-transfer coefficients. Its header volume was quite small; however, the ineffective heat-transfer volume caused by the tube bends to provide for expansion was quite large.

A study was made to determine the optimum tube size. The maximum surface per unit volume will be the case of maximum flattening; however, pressure drop must be considered as well as the fabrication of a practical tube sheet. Based on these considerations, $^3/_4$-in-diam round tubes with 0.035-in. wall were selected. These were swaged at both ends, bent to the proper shape, and flattened. After flattening, the outside dimensions were 1.032 in. × 0.230 in. There are 86 NaK tubes and 84 sodium tubes having an effective heat-transfer area of 59.6 sq ft. Experiments were performed on all these operations before fabrication of the exchanger was started. Swaging was done on an opposed-hammer swager. The tubing was bent by hand on a mandrel, and no difficulty was experienced in flattening the tubes. They were filled with water in a pressure system set to relieve at 2000 psi pressure. Flat-ground upper and lower platens were used on a hydraulic press, and removable blocks, ground to the desired tube thickness, were inserted adjacent to the tube.

Nickel welding experience on this unit showed that atomic hydrogen gave porous welds, argon-shielded arc showed gas pockets, and helium-shielded arc gave sound welds. At the time of design, the only weldable materials suitable for use with sodium and NaK were L-nickel and type-347 stainless steel. The higher thermal conductivity of nickel makes it very desirable for tube material since its use reduces the heat-exchange volume by approximately 20 per cent. For this unit it was decided to use nickel for the entire exchanger. This made the joining of the tubes to the tube sheet a simple rolling and seal-welding operation. The unit was cleaned by circulating a cleaning fluid through each tube and blowing out with air. The shell and headers were wire-brushed on the inside and washed with cleaning fluid. For design purposes, the film heat-transfer coefficients for Na and NaK were determined from the Martinelli theory as applied to flat plates (2).

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[1] Head, Heat Transfer Systems Sub Unit.

[2] Engineering and Production Section. Jun. ASME.

[3] The Knolls Atomic Power Laboratory is operated for the U. S. Atomic Energy Commission by the General Electric Company.

[4] Numbers in parentheses refer to Bibliography at end of paper.

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Shell-and-Tube Heat Exchanger. An alternate unit was chosen for testing. This was a counterflow, single-pass shell, single-pass tube heat exchanger. This unit was built by The Babcock & Wilcox Company. The shell side was shrouded but not baffled. Double-walled L-nickel tubes were used with sodium inside the inner tubes, NaK flowing outside the tubes, and static sodium filling the annuli. At the time of the design of this exchanger, it was felt that an investigation should be made of the effect of large changes of heat flux on performance. This involved reducing the heat-transfer area of the exchanger; therefore the exchanger was constructed in two parts and valving was such that both fluids could flow through the exchangers in series, parallel, or individually, and each unit would be in counterflow. Inasmuch as two units for this exchanger had been decided upon, it was felt that one unit should be horizontal and the other vertical to determine if there was any difference in performance as a result of position.

In the internal arrangement, the outer tubes were welded to an inner tube sheet and the inner tubes welded to the outer tube sheet. The space between the tube sheets formed a reservoir for the static sodium (third fluid). The differential expansion between the inner and outer tubes and the shell was taken up in the two bellows. The bellows are connected on one end to the shell, and the other end to the tube sheet through a bell-shaped housing. A shroud was provided to confine NaK flow within the tube bundle. The shell-side inlet flow was distributed through six peripheral holes, and the exit flow passed through similar holes. In this exchanger the joint of L-nickel to 347 stainless steel was made by welding the nickel tubes to a stainless tube sheet. Cleanliness was maintained by washing the parts after each operation. Leak tightness was assured by leak-testing the unit at nine stages of its assembly. Seventy-two double-walled tubes were used. The inner tubes were $^1/_2$ in. OD × 0.430 in. ID and the outer tubes were $^5/_8$ in. OD × 0.545 in. ID. The heat-transfer area based on the outside diameter of the outer tube was 40.2 sq ft per unit or 80.4 sq ft total area.

For design purposes, the over-all heat-transfer coefficient was based on film coefficients of the Martinelli theory for liquid-metal heat transfer inside round tubes. No adjustment was made due to the NaK flowing outside the tubes except that the characteristic dimensions appropriate for shell-side calculations were used.

STEAM GENERATORS

A natural-circulation steam generator and a forced-circulation steam generator were built for these tests. It was hoped that the forced-circulation unit would give information on performance of liquid-metal steam-generation equipment at various exit steam qualities which would aid in the design of future equipment. In addition, the greater flexibility of the forced-circulation unit enables it to give a wide range of heat-transfer data not obtainable from conventional boilers because of the high combustion-gas thermal resistance.

At the time of the design of these steam generators, consideration was given to the possibility of local heat fluxes occurring at values high enough to produce film boiling. The forced-circulation steam generator offered an excellent opportunity to investigate vapor-binding conditions if they occurred at the fluxes used. Though the natural-circulation unit lacked the flexibility of the forced-circulation unit it was considered to be more reliable since it did not require a recirculating pump. This reliability is of considerable importance in units to be designed for radioactive service; however, the requirements of any specific application may dictate one type or the other.

Forced-Circulation Steam Generator. This unit, was constructed by Combustion Engineering-Superheater, Inc. It consisted of two steam drums, two evaporators, and a superheater section. The liquid-metal circuit contains suitable valves and piping to allow series or parallel flow through the evaporators. The steam path was made up of two parallel circuits which flowed through the two evaporators in series. The parallel circuits are provided with separate drums and with individual feed controls. It was possible to determine the difference in performance of the two circuits. For the purposes of this paper, the average performance of the two circuits is reported since the results indicate the difference of performance to be less than the control accuracy on the two circuits. A single recirculating pump served both circuits and is controlled by a brush-shaft motor.

The evaporators and superheater were multipass-tube and single-pass-shell exchangers having the NaK in the shell and the steam in the tubes. The double-tube construction used SA 213 T11 for the inner tube which was $1^1/_2$ in. OD with a 0.120-in. wall and SA 213 T19 for the outer tube which was $1^3/_4$ in. OD with a 0.095-in. wall. The annuli between the tubes was filled with triple-distilled mercury. The shells of the exchanger were also SA 213 T19 (type-347 stainless steel). The construction of the three exchange units is identical except for the length of the superheater. The differential expansion of the tubes was provided for by a shroud serving as the outer return head which allowed the inner tube to slide freely. The evaporators and superheater all had separate third fluid systems. This allowed better location of any leak which might be detected. The mercury pressure was maintained at 200–250 psi by an argon blanket. An appreciable change in this pressure caused the pressure recorder to sound an alarm. The liquid-metal pressure was approximately 50 psi and the steam pressure was 500 psi. This allows the direction of the leak to be determined.

Natural-Circulation Steam Generator. This generator was built by The Babcock & Wilcox Company. It had two evaporators, a superheater section, and a single steam drum. The liquid metal flowed into the superheater, then in parallel paths through the evaporators. The water flowed by thermal circulation from the drum through two downcomers to a common header, then to the evaporators through parallel paths back to the steam drum. An oversize cyclone separator was provided on the drum discharge to the superheater section to prevent carry-over.

The superheater was a shell-and-multipass-tube unit. The evaporators were counterflow shell-and-tube units having higher heat-transfer effectiveness than the multipass type but requiring a bellows expansion joint. The NaK was on the shell side in both cases. The double-tube construction used SA213T19 for the outer tube and SA280 for the inner tube. The nominal tube sizes were identical to those in the forced-circulation unit. The expansion of the tubes in the superheater is taken care of by a floating-head design. In the evaporators, this was done by means of the bellows which connected the inner tube sheet and the shell. The use of two evaporator sections was originally proposed in order to keep the size of this bellows to a minimum. The mercury used between the tubes of this unit was treated with titanium and magnesium to determine the effect of these wetting agents.

METHOD OF OPERATION

The tests were conducted in a manner which might be typical of operation in a power plant. The outlet temperature of the source was maintained constant for each set of tests at a level of 750 F, 850 F, or 950 F. The steam pressure was maintained constant at 500 psia, with all the steam going through the superheater section. No attempt was made to control superheat temperature. The liquid-metal flow rates were

controlled to the desired load from approximately 7 to 125 per cent of rated flow. For all the tests reported here, the operation of the liquid-metal heat exchangers was with sodium and NaK flowing at equal heat-capacity rates.

Principal temperature measurements were made with platinum-resistance thermometers with a precision hand balance Wheatstone bridge to ± 0.5 deg F. Necessary precautions were taken to insure the measurement of mixed-mean temperatures at all points. Iron-copnic thermocouples were employed for measurement of temperatures of secondary importance. The power load was determined by condensing and weighing the steam generated with an accuracy of ± 1.5 per cent. The liquid-metal flow rates were measured by means of electromagnetic flowmeters (3) and special rotameters. The precision of both instruments was ± 2.5 per cent as checked by heat-balance methods. Pressure-drop measurements in NaK have been made with pneumatic differential-pressure cells as well as with Bourdon-tube gages. For the sodium system, operational difficulties prevented reliable pressure-drop measurements over the range of flows employed.

RESULTS

Flat-Tube Heat Exchanger. The over-all heat-transfer coefficients are shown in Fig. 1 as a function of NaK Reynolds number since this is the controlling convective resistance. These coefficients were obtained from the expression

$$U = \frac{Q}{A\theta_m} \qquad [1]$$

The heat-transfer area used for this exchanger was determined by projecting the inside area of the hot tubes upon the cold tubes and adding a corrected area for the tube edges as determined by flux plot. This "shadow" area represents only those portions of the tubes which are in intimate contact. The total geometric area from tube sheet to tube sheet is 83.3 sq ft, while the effective area is 59.6 sq ft. The log mean temperature difference was used as for a counterflow exchanger though 13 per cent of the area might be classified as crossflow. An analysis for the change in effectiveness caused by this crossflow was made at the suggestion of H. A. Johnson. The relationships of Nusselt (4) were used and the contribution was proved negligible. The curve showing Martinelli's theory is a prediction based upon conventional flat-plate series resistances. The third fluid is treated as a conductive resistance since an estimate of free-convection boundary-layer thickness indicates there can be no thermal convection.

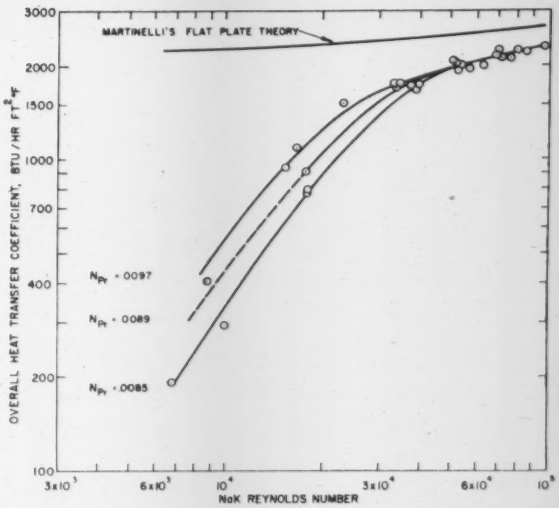

FIG. 1 OVER-ALL HEAT-TRANSFER COEFFICIENTS OF SODIUM TO NaK FLAT-TUBE HEAT EXCHANGER

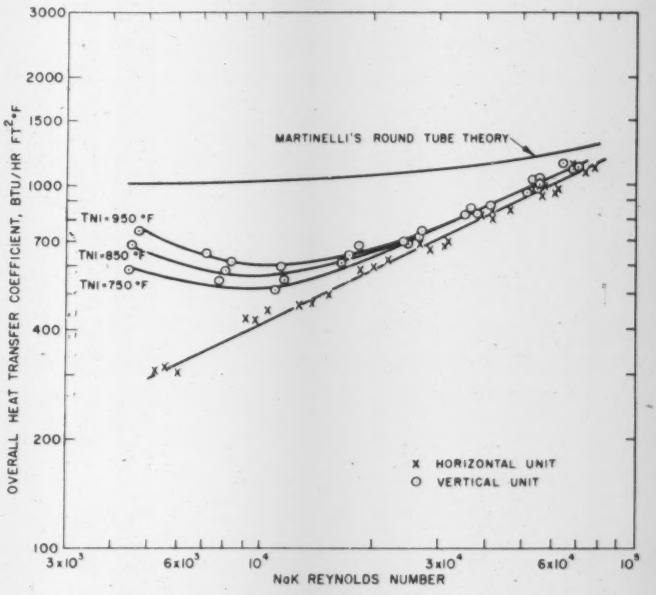

FIG. 2 OVER-ALL HEAT-TRANSFER COEFFICIENTS OF SODIUM TO NaK SHELL-AND-TUBE HEAT EXCHANGER

The experimental results show two significant points. The first of these is the rapid decrease in the over-all heat-transfer coefficient as flow decreases. The nature of the construction of this unit with parallel flow paths of various length immediately suggests that this must be due to poor flow distribution which would reduce the effective heat-transfer area accordingly.

The minimum developed length of tube was 5.41 ft as compared to 6.53 ft for the maximum length. In addition, the header design is such as also to contribute to the poor distribution of flow. An investigation of temperature distribution at the outlet headers of this unit is presently under way to determine the nature of flow within the exchanger. At the same time, due consideration is being given to the possibility that the film heat-transfer coefficients might decrease in this fashion owing to the peculiar geometry of the tubes. An experiment with a single element has been started to give further information since there is a dearth of experimental results on noncircular ducts.

The second point of significance is the spread of values at low Reynolds numbers. As indicated in Fig. 1, the change in Prandtl modulus is quite small and could hardly be the major factor. The other variable not shown in Fig. 1 is the heat flux. The method of operation gave appreciably higher heat fluxes for the lower-Prandtl-number tests. As yet, a satisfactory method of separating the convective resistances has not been found, but it is hoped that the single-element test may aid in this separation. At that time it should be possible

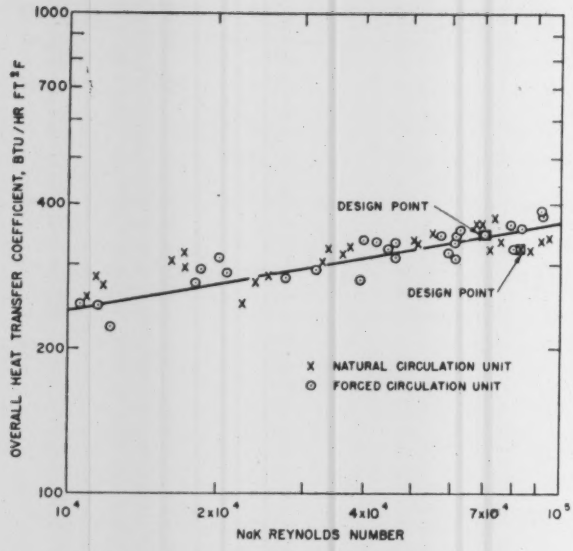

FIG. 3 OVER-ALL HEAT-TRANSFER COEFFICIENTS OF NaK TO WATER EVAPORATORS

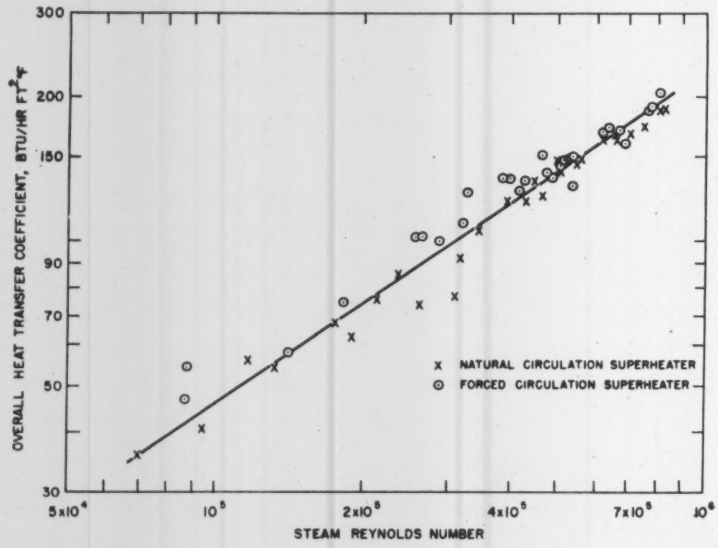

FIG. 4 OVER-ALL HEAT-TRANSFER COEFFICIENTS OF NaK TO STEAM SUPERHEATERS

to give a more complete analysis of the heat-transfer characteristics of this unit. It is encouraging to note that at rated flow conditions the agreement with Martinelli is within 15 per cent which is acceptable accuracy for heat-transfer design.

Shell-and-Tube Heat Exchanger. The over-all heat-transfer coefficients for the horizontal and vertical components are shown in Fig. 2 as a function of NaK Reynolds number. The NaK is on the shell side in each case and the characteristic dimension used is the tube outside diameter. The over-all coefficients were calculated using Equation [1] with the heat-transfer area taken as the total outside tube area. The curve showing Martinelli's theory is a prediction based upon cylindrical conductances

$$\frac{1}{U_o A_o} = \frac{1}{h_o A_o} + \frac{\ln A_0/A_1}{2k_{o1}} + \frac{\ln A_1/A_2}{2k_{12}} + \frac{\ln A_2/A_i}{2k_{2i}} + \frac{1}{h_i A_i} \quad \ldots\ldots\ldots [2]$$

The third fluid was again treated as a conductive resistance. The convective resistances were found from the round-tube results given by Martinelli.

The experimental results indicate a considerable difference in performance between the two units. At high flows the results are actually the same for both units if the Peclet number is used instead of Reynolds number. At low flows, the thermal configuration of the shell side apparently is responsible for the difference. The vertical unit has its shell-side fluid increasing in temperature as it rises and thus decreasing in density. This buoyant force has the effect of increasing the velocity and hence increasing the film heat-transfer coefficient. At the same time the tube-side fluid is being cooled as it descends and accomplishes the same effect. The method of operation was such that for any given temperature level, the temperature rise in the shell-side fluid increased as flows decreased. This accounts for the increase in the coefficients at low Reynolds numbers. It also indicates that the magnitude of the thermal convection is not insignificant compared to the forced convection. The initial sodium temperatures also indicate the reason for the separation which occurs at low flows. The higher the initial temperature the greater the thermal driving force. The horizontal unit does not have this additional driving force and hence does not show the increase in heat-transfer coefficient at low flows. There was no variation in the coefficients for the horizontal unit at the three source temperatures of operation. The large discrepancy between the horizontal unit and the Martinelli theory is attributed to overextension of the theory rather than poor flow distribution. At rated flows the agreement was within 10 per cent which seems quite good. By using the round-tube data on the tube side, a separation was possible and has been used in a generalized shell-side correlation shown in Fig. 3.

Superheater. The over-all heat-transfer coefficients of the superheater are shown in Fig. 4 as a function of steam flow which is the controlling resistance. The design points indicate that the original estimate was somewhat conservative for the forced-circulation superheater. An analysis of results has shown that the NaK coefficient was low. Original estimates for part-load conditions based on the momentum-transfer analogy were quite poor and have not been included. By using the correlation obtained from the shell-side data of the shell-and-tube heat exchanger and the evaporator sections, it has been possible to separate the average film heat-transfer coefficient of the superheated steam. Excellent agreement was obtained with the McAdams (5) correlatio . The resistance of the steam film was considerably larger than either the tube wall or the NaK film; therefore the accuracy of the determination was very good. No corrections for thermal radiation to the steam were made but a check of this proved it to be insignificant except at very low steam flows. Special emphasis was placed on separator design to prevent carry-over and an examination of the tubes of the natural-circulation superheater section failed to show

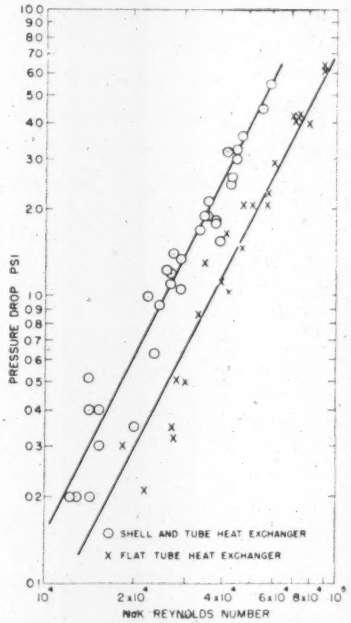

FIG. 5 NaK SIDE PRESSURE DROP OF SODIUM TO NaK HEAT EXCHANGERS

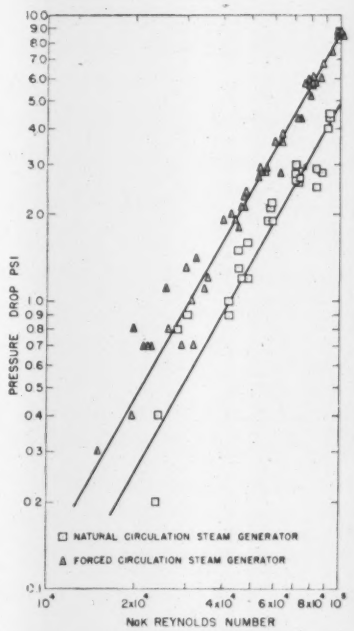

FIG. 6 NaK SIDE PRESSURE DROP OF NaK TO STEAM GENERATORS

any signs of scale due to carry-over. In addition, heat balances failed to show any signs of excessive heat loss due to entrainment. After more than 2000 hours of operation of the superheater, which was removed for metallurgical examination, there were no signs of fouling on either the liquid-metal or steam side. A light coating of iron oxide was found on the steam side but was not considered of sufficient magnitude to be of concern. Check runs on these units also have shown no deterioration in the heat-transfer performance. Approximately 7,000,000 net lb of steam has been generated and passed through this superheater.

Evaporators. The over-all heat-transfer coefficients are shown as a function of NaK Reynolds number in Fig. 3. The design points are given merely as a matter of interest since reliable physical properties were not available when the designs were made. Excellent agreement is indicated with experimental results, despite the lack of good property data. A number of predictions were made at the time of design for part-load performance on the basis of both thermal and forced convection of the shell-side NaK. For simplicity these have been omitted, but it suffices to say that there was no agreement. A separation of the average film heat-transfer coefficient for the NaK was made and is included in the correlation described later.

The experimental data show no appreciable difference in over-all heat-transfer coefficients for the two units. The water-circulation ratios varied over the range of approximately 1:20 to 1:2 but no definite pattern was established. However, the test runs to date have not been made under conditions designed to study this specific item. A limited program for investigation of this factor has been planned. However, it should be pointed out that the principal thermal resistance in this unit is in the tube walls and the minimum thermal resistance is in the boiling-water coefficients. This means that the sensitivity of measurement for the effect of exit quality is not an optimum value. At the same time, this has meant that the evaluation of the NaK coefficients can be done with reasonable accuracy. In addition, an attempt is being made to determine experimentally the resistance of the tube walls, which should increase the accuracy of the film heat-transfer coefficients. Several periodic check runs were made to insure that fouling did not occur on the water side. To date, no deterioration in the over-all heat coefficients has been observed. The reproducibility of values has been within ± 3 per cent.

Pressure Drop. As mentioned earlier, the techniques of measuring pressure drop in liquid metals are not as yet fully developed for wide ranges of flow. In Figs. 5 and 6 the results for the NaK sides of the heat exchangers and steam generators are shown. At low flows particularly, the measurements are only fair, but an effort is being made to improve the instrumentation and its application. Fig. 5 gives NaK side the pressure drop of the heat exchangers as a function of Reynolds number based on tube diameter. The pressure drop is found to be proportional to the square power of flow for both heat exchangers. The measurements were made from inlet nozzle to exit nozzle and hence conversion to friction factor is somewhat marginal. The values of the shell-and-

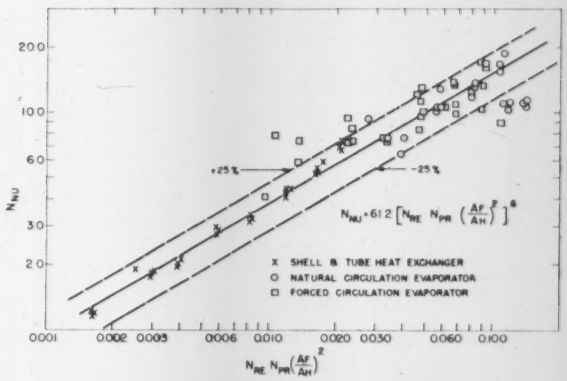

FIG. 7 SHELL-SIDE HEAT-TRANSFER COEFFICIENTS FOR LIQUID METALS

tube heat exchanger are for the individual units. No difference was detected between the vertical and horizontal units. The pressure drop per unit area of heat transfer is considerably larger in the shell side than in the unmixed fluid of the flat-tube heat exchanger. In the original design this was not a prime consideration and presumably could be improved.

Both of the units are within the original design limits. At rated flow, the limit was 5.0 psi for the flat-tube heat exchanger and the measured value is 4.1 psi. The round-tube heat-exchanger limit was 5.0 psi as compared with a measured value of 3.2 psi.

For the steam generators the pressure drop is found to be proportional to the 1.8 power of flow for both units. The measurements were made from the inlet nozzle of the superheater to the outlet nozzle of the evaporators. In the forced-

circulation unit, the superheater and evaporators were in series flow and hence the average pressure drop for a typical section would be approximately one third of the total. The natural-circulation unit had the evaporators in parallel and hence the typical reaction pressure drop would be approximately eight tenths of the total. At rated flow this gives 1.9 psi pressure drop per section in the forced-circulation generator and 2.0 psi per section in the natural-circulation generator. This agreement was expected since the design of the liquid-metal paths is quite similar. The design limit for both of these units was 5.0 psi at rated flow. The forced-circulation measured loss was 5.8 psi and the natural-circulation was 2.3 psi. No attempt has been made to reduce the pressure-drop measurements to friction factors, because the readings are overall.

Shell-Side Heat-Transfer Coefficients. The results of the horizontal shell-and-tube heat exchanger, the forced-circulation top evaporator, and the natural-circulation evaporators have been correlated as shown in Fig. 7. The characteristic dimension used in N_{Nu} and N_{Re} is the tube outside diameter. The physical properties (6) were evaluated at the average bulk temperature. The range of N_{Pr} was from 0.0076 to 0.0104. In all cases the fluid was NaK (44 per cent Na). The term A_F/A_H represents the ratio of flow area to heat-transfer area. There was a wide range of the ratios since the liquid-metal heat exchanger was composed of small tubes closely packed while the evaporators had large tubes in a relatively open arrangement.

The separation of the mean film heat-transfer coefficients was made using Equation [2]. For the liquid-metal heat exchanger, Martinelli's round-tube results were used. For the evaporators, the boiling data obtained at the University of California (7) and the Massachusett's Institute of Technology were used.

While it is recognized that these data are only an approximation of the actual conditions which prevail as they are for film boiling, the boiling resistance represents only a minor portion of the total. Therefore, the accuracy to be expected is not unfavorable for a valid correlation. For the natural-circulation evaporators, the mean values of the two units were used. No correction was made for the constant wall-temperature conditions as suggested by Seban and Shimazaki (8). The mean deviation for the relation

$$N_{Nu} = 61.2\left[N_{Re}\,N_{Pr}\left(\frac{A_F}{A_H}\right)^2\right]^{0.60} \quad \text{or} \quad N_{Nu} = 61.2\,N_{Pe}^{0.60}\left(\frac{A_F}{A_H}\right)^{1.2} \qquad [3]$$

is found to be ± 15 per cent. The lines of ± 25 deviation are shown on the curve.

A number of other correlations were considered, including the Donohue (9) relation, but the one presented gave the best results.

CONCLUSIONS

The testing of the equipment described has given a better understanding of a number of design aspects for liquid-metal heat-exchange equipment. In addition, heat-transfer coefficients for shell-side conditions have been evaluated. From this work it is seen that excellent heat fluxes up to 150,000 Btu/hr sq ft are possible in spite of the additions of thermal resistances which must be introduced to give extremely high reliability to equipment for nuclear power plants. There are a number of points which appear to be worthy of consideration in the design of such units:

1 When units having parallel paths of unequal length are designed, there may be a serious reduction in the effective heat-transfer area at low flows owing to poor flow distribution. Use of a hydraulic diffuser, to improve flow distribution appears to be possible in cases where such a reduction represents a serious problem.

2 For vertical units it is possible to take advantage of the thermal-circulation contribution for upflow heating; and downflow cooling to increase over-all heat conductance. Conversely, when upflow cooling and downflow heating are used, a decrease in heat conductances would be predicted.

3 For Reynolds numbers greater than 50,000 it has been found that the momentum-transfer analogy is satisfactory for design purposes.

4 In more than two and a half years of operation under a wide range of test conditions, no deterioration in heat-transfer coefficients as a result of fouling has been observed. This is true for both liquid-metal heat exchangers and steam generators.

This paper represents a report on a continuing problem and a number of items remain to be investigated. Among these is an investigation of the effect of quality on steam generation for optimum operation of nuclear plants. It is also expected that heat fluxes can be increased materially and will require an investigation of the limitations involved. It is planned to extend the shell-side correlation by use of sodium in the units tested and by obtaining data for units of different geometrical proportions.

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Development of SPECIAL PUMPS *for* LIQUID METALS

Their Power Supply, Valves, Bearings, and Instrumentation

By EDWARD F. BRILL

CHIEF ENGINEER, ATOMIC POWER SECTION, ALLIS-CHALMERS MANUFACTURING COMPANY, MILWAUKEE, WIS

INTRODUCTION

IN planning and designing nuclear power plants the pumps or blowers required for circulating coolant through a reactor for transfer of heat to a power cycle or heat sink require special consideration. These pumps play an important part, for they must circulate a coolant through the reactor for effecting the transfer of heat to a heat engine for conversion to mechanical or electrical energy without failure, without leakage, and without maintenance for long periods.

In attempting to accomplish this, the pump designer or application engineer must analyze the following before he can select the best type of pump unit: He must know the full range of expected operating conditions, the frequency of accessibility for repair or servicing, and any special associated system or control requirements which may be of advantage or disadvantage in determining the specification of a pump for a particular service.

The property of liquid metals which provides the most important reason for the selection of a liquid metal as a coolant fluid, is low vapor pressure at elevated temperatures. It is this property which allows liquid-metal coolants to be circulated at low system pressures in fairly lightly constructed piping and heat-transfer vessels, and which permits a high delta-T reactor with minimum penalty in loss of neutrons by absorption in heavy-walled tubes or pressure vessels.

There are several characteristics of liquid metals which allow a wider selection of pump types. The low electrical resistivity of certain liquid metals makes it possible to use electromagnetic pumps. Several fluids, such as sodium, sodium-potassium alloy, and lithium, for example, fall in this category. Liquid metals with a low melting point, of which mercury is the best example, with sodium-potassium alloy as a second very good example, eliminate the need for keeping the pumps and piping system heated at all times. Others have low density, which reduces the total pumping power required, a good example being lithium. Further considerations which affect the design are corrosion rates on various materials, the effect of leakages to the surrounding space, the hazards connected with such leakages, and the degree of accessibility for doing repair or maintenance work. Most of the liquid metals have good thermal conductivity, good wetting properties, are stable fluids, and have a fairly high specific heat.

Liquid-metal pumps are often classified into two general types, the first being the electromagnetic, of which there have been numerous designs for flows up to 20,000 gpm, all making use of the principle that a force acts on a current-carrying conductor disposed in a magnetic field at right angles to the conductor, the second being mechanically driven pumps of the shaft-seal or hermetically sealed design.

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ELECTROMAGNETIC PUMPS

In one electromagnetic type, called the Faraday, a heavy current is made to flow through the fluid. The current enters the pipe wall through a brazed joint. A magnetic field is established at right angles to the direction of current flow by means of a permanent magnet, a separately excited electromagnet or a series-excited electromagnet. A number of pumps have been built on the Faraday principle. In general, the best performance is obtained in designs embodying the use of 100 per cent compensation; this is achieved by passing a current through a conductor along the top or bottom of a pump throat section in opposite direction to the current flowing through the fluid in the throat of the pump. By compensating in this manner, it is possible to prevent the nonuniformity of the magnetic field which otherwise would result. A larger force is developed on the fluid in the compensated pump owing to the fact that the current is uniformly distributed along the length of the pump, and the magnetic field is similarly distributed. It can be shown that the head developed by a noncompensated pump will reach a peak and will then diminish as the current is further increased in value. A compensated pump, on the other hand, will continue to increase the head developed on the fluid as the current is raised. Compensation can be effected in other ways. These methods, in general, involve the use of pole shaping and are, therefore, effective at only one particular point of rating.

An interesting combination consists of applying the known principle of the Faraday pump design with compensation and using some of the copper required for compensation as a portion of a single-turn series-excitation coil. In this design a very compact pump results. The series excitation makes use of the very high current which is required in the throat of the Faraday pump. Consequently, a great number of excitation ampere turns can be put into a very small space without much consideration for electrical insulation, the insulation being required for only a low voltage to ground; hence a small air gap provides sufficient insulation.

Another type of electromagnetic pump, the electromagnetic centrifugal, which has been designed, built, and tested, consists of a machine in which a group of circumferentially spaced magnetic-field poles are rotated mechanically in close proximity to a thin annulus carrying liquid metal. The magnetic field in one design is directed axially through the fluid to a backing laminated-iron structure, conducted along this backing iron structure, and again back through the fluid to another pole of opposite polarity. This magnetic field, when rotated, induces voltages in the conductive liquid-metal fluid, producing a current which reacts with the applied field, causing the liquid

metal to move in the thin annulus between the poles and the backing iron. It is thus possible to design a pump, looking very similar to a centrifugal pump, having as vanes the effective shape of the magnetic-field poles.

In this design the liquid metal is drawn into the center, as in a normal centrifugal pump, and passes through stationary prerotational vanes outward into the pumping annulus where energy is applied by the so-called magnetic vanes. This energy causes the entire fluid in the annulus to rotate and, consequently, to pump the liquid metal centrifugally outward to a conventional-type volute. This results in a pump having the appearance of a very low-specific-speed impeller for the actual speed of the rotor, requiring, however, a little larger net-positive suction head than a conventional centrifugal pump for the same rating.

This pump has several advantages, such as (*a*) no moving parts in the fluid being pumped, (*b*) flow control by varying the speed of the rotating magnetic structure, (*c*) flow control by keeping the speed constant and varying the field-excitation strength, and (*d*) exciting coils are self-cooled as a result of inherent fan action. Pumps of this type have been built and tested with close conformity to the design.

The electromagnetic centrifugal-type pump also is designed as part of a complete sealed package unit consisting of pump, drive motor, and heat exchanger. With this construction complete safety is assured by having a heavy metal enclosure surround the unit even though the fluid inside is contained within a rather "thin-wall" structure. By this system any possibility of outward leakage is avoided. The built-in heat exchanger has sufficient capacity to remove the normal motor losses and losses in the rotating magnetic structure.

Another type of pump unit which has been built and tested is the a-c linear induction pump. In one type an a-c winding causes the progressive motion of a magnetic field down the length of a flattened pipe. To understand most easily the action of this type of pump, one is usually asked to visualize taking an induction motor and cutting through the stator axially at one point, then unrolling the stator out flat, and taking this flat portion and placing it in close proximity over a flattened pipe with a magnetic core below the pipe, or a duplicate winding below the pipe, to complete the flux path. When energized by an a-c power supply, the electrical moving field will induce voltages in the fluid causing currents to circulate which, in turn, tend to make the fluid follow the applied field. This type of unit has been designed and tested with a certain degree of success.

The a-c linear induction pump also has been built in a modified form, generally known as the Einstein-Szilard type pump. This pump takes one additional step in that the flattened induction motor is wrapped up at right angles to the previous rolling, so that the coil ends come together, eliminating the triangular diamond-shaped coil ends, and resulting in a series of spaced spirally wound hollow-conductor liquid-cooled multiturn coils. This design requires placing a magnetic core inside the resulting stator to complete the flux path, with the space between the stator and the center core being lined by two concentric thin-walled tubes, one on the core outer diameter and the other on the stator inside diameter, thus providing an annular flow space for the liquid metal between these two thin walls. Thus the fluid as it moves through the pump, assumes a hollow cylindrical shape. This pump offers the advantage of good inlet and exit hydraulic characteristics, good design for strength and thermal expansion, and permits reduction of the so-called "end effects" that appear when a conducting fluid suddenly enters or leaves a magnetic field.

Pumps of this type have been built and tests indicate close conformity to calculations. Several modifications of the general type have been made, and it is expected that this type of pump will find wide usage in the field of pumping liquid metals for the following reasons: (*a*) It has no moving parts; (*b*) it can be designed for the readily available 60-cycle power supply; (*c*) its weight and space requirements may be kept to a minimum; and, furthermore, (*d*) such a unit can be built to minimize the problem of thermal stresses. A further modification known as the reverse-flow Einstein-Szilard pump permits removal of the stator winding without cutting the loop piping and offers improvement in the structural design to secure a strong center-core support.

FARADAY-PUMP POWER SUPPLY

Faraday pumps have been built with both a-c and d-c power supplies, but it is generally recognized that the d-c pumps are far more efficient than the a-c pumps. This results in the a-c pumps being used only for small transfer-pump service, whereas the d-c pumps have been designed for capacities in the tens of thousands of gallons per minute. For the a-c pump, the power supply is generally a transformer with a single turn (or a possible 2-turn) secondary.

In investigating the power supply for a d-c Faraday pump, one must look for a source of low d-c voltage and very high current. Several types of high-current low-voltage power sources are available. These are rectifiers with their inherent low-efficiency characteristics at low voltages; direct-current commutator-type machines which are inefficient at low voltages owing to the high brush drop; the use of batteries which, in general, proves to be a nuisance from the application and maintenance viewpoint; this leaves as power supplies two types which are considered practical. The one involves using a Faraday pump operated in reverse as a generator by forcing or pumping a conducting fluid through the throat section of the pump thus producing a low-voltage high current. When a liquid conductor is pumped through the throat section of a Faraday pump with the field excited, a voltage is produced which causes a current to circulate in a closed circuit. This principle proves to be a simple way of getting a very high-current low-voltage direct current. This resulting Faraday generator unit, when closely connected to a similar Faraday pump unit, provides power for the pump unit, and the combination is referred to as a dual-flow pump-generator.

This principle can be used to cause pumping of more than one fluid simultaneously. The advantage of this type of system is apparent in applications to a nuclear power plant where such a unit can be located in close, right in a region of high neutron or gamma radiation such as that surrounding the core shielding of the reactor where the heat exchanger also is located. The use of a pump requiring no mechanical moving parts in this region would appear highly desirable, with flow actuated by a more conventional type of pump located outside the gamma shield in a region which has greater accessibility, where moving parts of a pump can be made accessible for service.

The other and probably the most efficient method of producing a high-current low-voltage source of power consists of using one of the two types of unipolar generators recently developed by the author's company. These generators are classified according to the way their current collectors are designed to operate. At present there are two main types, namely, a flooded collector type and a disk collector type. In the flooded type we have a rotor running completely submerged in a liquid metal and operating in a magnetic field; in the other, or disk collector type, the rotor operates in a magnetic field but is wetted by liquid metal at very limited regions which are known as the collector locations. The two types have been built and tested, and are considered highly

satisfactory machines for the production of high current at low or moderate voltages.

The unipolar generator is, of course, a very old type of generator, being probably one of the earliest types ever built for the production of direct current. It was regarded in the past as being necessarily a very large machine owing to the complications arising in the design of a collector or brush assembly. This collector or brush assembly, because of the inherent design, must be surrounded by the field structure of the generator; consequently, all the flux-carrying iron surrounds the brush assembly so that where carbon brushes are used, with their limited ability to carry a high electric current density, a large brush rigging results, hence a machine of enormous proportions. This brush feature alone has been the chief limitation to the application of the unipolar generator.

It is because of the ability of liquid metals to act as current collectors that the true merits of the unipolar generator again are receiving consideration. Unipolar generators can be built to provide not only low voltages, but also intermediate voltages. The unipolar generator produces a true unidirectional voltage of constant magnitude. A voltage is developed in the rotor along the surface of the rotor directly under a pole when the conductor is rotated in a magnetic field. A current will be circulated by completing the circuit from the rotating element to the stationary collectors and the load. The transfer of current from the rotor to the collectors is accomplished by having the surfaces of the rotor and the collector submerged in and wetted by the liquid metal. Liquid metals can carry extremely high-current densities, and the heat developed in carrying these high currents can be dissipated by circulating the liquid metal to a heat exchanger.

Unipolar generators have been designed currently for ratings as high as 200,000 amp, and at voltages as high as 75 volts. In general, these generators are most attractive as extremely high-current-carrying machines. They will, as the initial applications prove successful, find their way into many fields, particularly in the electrolytic, chemical, and metallurgical fields for process work, and in the mechanical-drive fields for the production of very high or low rotor speeds or variable torques. Since the rotor of a unipolar machine, in general, is a very simple unit without complicated slots, higher working stresses may be employed than conventional machines can use.

MECHANICAL PUMPS

In addition to the basic electromagnetic pumps herein described and the numerous innovations that can be incorporated in them, several types of mechanical pumps have been designed using the principles of hermetic sealing and various shaft seals which allow zero or minimum outward leakage of the pumped fluid around the shafts.

Shaft-Sealed Pumps. A shaft seal was built and tested using what is termed an electromagnetic seal; the design made use of the basic idea of the Einstein-Szilard pump, with a rotating shaft passing through the core of the Einstein-Szilard exciting structure. As in the case of the Einstein-Szilard pump, a force is developed on the fluid surrounding the shaft. Thus we can have at one end of the rotating shaft a pressure of several hundred feet, and at the other end a pressure corresponding to atmosphere. An interesting feature of such a seal is that if it is designed for a vertically mounted shaft, the normal liquid level could be at approximately the center of the seal. Increasing the pressure at the lower end of the shaft would cause the liquid level to rise. This rise in liquid level would reflect itself and result in an automatically counteracting force increasing as the level rises along the shaft. This type of unit also has been designed for use as a packing around a shaft where an axial movement of the shaft is to be caused by the pressure of a liquid metal on the end of the shaft, acting in a similar manner to the hydraulic jack, with the electromagnetic shaft seal serving as the packing.

In various designs, end-face contact seals have been used to seal around a shaft in both direct liquid sealing and gas or other liquid interface applications. The life expectancy of such seals varies to such an extent that no critical application to liquid-metal pumps appears probable in the near future. A further limitation to contact seals lies in the fact that sealing lubricants which aid the operation of the seal are generally not permitted in the nuclear cycle.

Shaft-sealing using close-clearance labyrinth or high-speed large-diameter slinger disks, wherein a nominal leakage of inert gas is permitted, gives good results. A suggested design which permits even closer or no running clearance around the shaft involves the use of frozen-liquid seals. Here the liquid is frozen by a suitable cooling coil around a shaft. The heat developed by the rubbing contact locally melts the fluid, thus providing a film of liquid which seals the shaft. Since the temperature is maintained near the solidification point, only a slight oxide contamination takes place.

Hermetically Sealed Pumps. The author's company has designed and built three general types of hermetically sealed drives for mechanical pumps. These are canned induction-motor drives; unipolar-motor drives; and our turbomagnetic type of drive, which may be considered to be a canned eddy-current clutch, driven by a turbine or motor. All three types have been built in various sizes, from $\frac{1}{2}$ hp up to several hundred horsepower, each one for a specific type of application.

The canned induction motor can be used in both flooded and gas-atmosphere applications. It is well suited for applications requiring high system pressures, and has been tested at rotor temperatures of 1000 F. It is generally regarded as a highly dependable machine having a good over-all efficiency. The canned induction-motor drive can be used for all kinds of fluids and has been designed to handle fluids at 1000 F in the rotor space with the main impeller of the pump operating in a region of 1500 F.

The turbomagnetic drive finds its use in applications covering a wide range of temperatures with the maximum around 1500 F, being limited, however, to rather low-system-pressure applications. It has the advantage of variable-speed control with a change in d-c excitation.

The turbomagnetic drive has been built with both rotating and stationary coils. A greater future appears in store for the stationary-coil designs since the turbomagnetic drive, utilizing stationary exciting coils, can be liquid-cooled. Several designs of this type of drive have been worked out for pumping applications for temperatures of approximately 1500 F.

The unipolar motor can be used over a wide range of temperature applications, high pressure, and high speed. Its use, however, is confined to applications where liquid metals are handled in the cycle, or in cases where gases are used in the cycle and a liquid metal could be tolerated in the unipolar space.

The unipolar motor has been applied to pumping liquid metals, and offers a number of advantages. The motor can be built to operate efficiently with heavier-walled cans than the turbomagnetic or canned induction motor. It has the advantage of being essentially a low-voltage unit requiring little electrical insulation. The unipolar motor has been built in various ways for both conventional type of rotor construction, and so-called buoyant type of construction.

The work in canned induction motors has branched out into many types. Canned motors have been built with the stators cooled by forcing a gas through axial or radial passages, or axial or radial-spaced ductwork, motors with stator wind-

ings cooled by conduction utilizing copper wrapping over insulated coil ends, and designs for hollow conductors with both gas and liquid coolant inside of the stator conductors. Since the canned motor usually would be designed with an entirely enclosed stator, a suitable condition is created to permit the use of liquid-cooled hollow conductors. The stator conductors in a liquid-cooled motor are surrounded by an inert gas which contains practically no moisture. It is an atmosphere which offers ideal conditions to the stator windings since the windings are not subjected to oxidation, nor can they sweat when cooled by liquid passing through the hollow stator conductors, nor are they ever exposed to dirt, carbon dust, oil, or the effects of high windage velocities as in a conventional motor. Hence the motor can be designed to occupy a minimum space, and develops a maximum of power at low stator conductor-insulation temperature.

Various techniques have been developed for canning the rotors of these machines for applications where the rotor materials such as iron and copper are not compatible with the surrounding atmosphere or fluid. These rotor cans and stator cans are first checked by Zyglo and halide detectors and finally by a mass-spectrometer instrument to a leakage specification which, for all intents and purposes, can be considered absolutely tight.

Bearings. In connection with the design of canned induction motors, we have had to develop bearings which can operate using fluids which, in general, have no lubricating qualities. We have developed a pressure-positioned bearing which uses as a pressurizing fluid the material handled in the system or cycle. These bearings have been built and tested with fluids such as water, kerosene, sodium, sodium-potassium alloy, air, nitrogen, steam, helium, and other fluids.

This bearing is generally regarded as a bearing of almost infinite life, for it can be designed so that there is never any metal-to-metal contact, resulting in no wear on the parts. It is possible to build equipment with this bearing utilizing materials which would be unsuitable for other types of bearings. The bearing consists, in general, of three or more equally circumferentially spaced pockets which are open only at the side, facing the journal of the bearing. Pressure is supplied to each of the pockets through an orifice, the orifice reducing the supply pressure to approximately one half in the pocket region when the shaft is centered. The fluid leaks out of all sides of the pocket through the space between the rotating journal and the lips or the edges of the pocket, going from approximately one half the supply pressure to a lower or zero pressure. The afore-mentioned pressure ratios are generally true for a centered shaft. If, however, the shaft moves toward one of the pockets, the pressure is increased in that pocket because the leakage flow out of the pocket decreases causing less pressure drop across the orifice—hence a pressure build-up in the pocket. The opposite condition takes place in the pocket or pockets 180 deg from the first-mentioned pocket. Thus there is a restoring force tending to center the shaft.

Various schemes have been devised and tested to reduce the supply of fluid required for the bearing operation. One method consists of using bearing lips with labyrinth edges; another provides for throttling automatically the fluid supplied to the unloaded pocket of the bearing. The self-throttling-type bearing also amplifies the bearing-load capacity. These bearings are more fully described in a paper by Richard M. Higgins,[1] mechanical engineer of the author's company, and mention is made here of this type of bearing to familiarize engineers concerned with the design of pumping and other equipment for extreme conditions with equipment that is now available. It might appear that the power required to supply pressure to these bearings is quite high. This is true in very small applications, in which this power ranges up to 50 per cent of the motor power. However, design and experience have shown that the power for fluid piston bearings is less than 1 per cent of the total power for pumping in large-capacity pump units.

The fluid-piston bearing has been designed for shaft speeds as high as 40,000 rpm using a pressurizing liquid, and greater than 40,000 rpm using a pressurizing gas or vapor.

Early liquid-metal pumps of the mechanical centrifugal type were designed with the rotating elements buoyant; that is, the entire rotating element could float; hence there was no thrust load imparted to the bearings during starting. This was considered necessary at the time because of the concern that thrust bearings of the fluid-piston type could not be made to be started repeatedly. Since the fluid-piston bearing relies on a pressure to operate, the starts and stops of a pump permit rubbing on the parts when the pump supplying pressure to the bearings is operating below the minimum design pressure. Tests of more than 500 starts and stops indicate that no serious degree of wear takes place during the short time of starting. Most of the units which have been built started and came up to full speed in less than one second.

Valves. In line with our liquid-metal pumping problems we have constructed several types of valves. These include leakless type gate, globe, check, poppet, ball type, and a pressure-operated type, more commonly known as the Johnson valve.

Considerable life might be expected from valves using a bellows to seal the stems, and known materials in the seats of the valves that will withstand the normal opening and closing service. A greater assurance against valve failures due to leakage through a bellows is obtained in valve designs using double bellows for sealing.

Application of double valves in series to prevent outward leakage is often desirable since the piping can be opened between groups of valves after the space between valves has been blown clean of fluid with the aid of an inert gas.

Pressure-operated valves permit hydraulic operation of the valve-closing mechanism using as the motivating liquid the pressurized fluid from the main circulating pump.

FLOW-CIRCUIT CONTROLS

In the control of liquid-metal flow circuits it is highly important to know the following factors: (*a*) Temperature; (*b*) liquid level of open tanks; (*c*) rate of flow; (*d*) pressure.

Of the various factors only temperature measurements are readily obtainable utilizing existing present-day thermometer and thermocouple equipment. Therefore we are more concerned with the problems of liquid-level control, flow measurements, and pressure readings.

Inductance-Type Liquid-Level Indicator. Considerable development work has been done on an inductance-type liquid-level indicator. Basically, this indicator consists of a solenoid-type coil wound on a stainless-steel tube in which the liquid metal is allowed to rise. The inductance of the coil is then a function of the height to which the liquid rises in the coil. This relationship is approximately linear except near the ends of the coil. An exact theoretical analysis of this level indicator is rather difficult; however, by making several simplifying assumptions it is possible to predict the performance characteristic within about 10 per cent.

The methods of analysis used to predict the performance of both a mercury and a sodium liquid-level indicator checked with a fair degree of success with test results.

The device indicates inductance only, being rather insensitive to resistance changes of the inductance coil because of heating.

[1] "New Bearing Made of Any Material, Lubricated With Any Fluid," *Iron Age*, vol. 170, September 11, 1952, pp. 158–160.

The principle of operation is that the output voltage of an a-c Wheatstone bridge, of which the unknown inductance is one leg, is fed to a phase-sensitive circuit which indicates only the inductive component of voltage. This voltage is proportional to the value of the unknown inductance.

The circuit consists of an oscillator and amplifier for supplying the alternating voltage to the bridge, the bridge itself, an amplifier for the output of the bridge, a phase shifter, and amplifier for the reference voltage which is obtained from the same source that supplies the bridge, and the phase-sensitive circuit which indicates the inductive voltage only.

Although the indicator responds only to inductive voltage, compensation for resistance change of the inductance to be measured has to be included in the bridge circuit, since the bridge output voltage is applied to the grid of a vacuum tube which might be driven so far by resistance unbalance as to cause cutoff or positive grid and render the circuit inoperative. Compensation is accomplished by winding a noninductive coil of the same length and size of wire over the coil to be measured so as to undergo the same temperature changes. The noninductive coil is included in the leg containing the standard inductance and balances resistance changes of the unknown inductance. Referring to the bridge section, the unknown coil has inductance L_X and resistance R_X. The standard coil has inductance L_S equal to L_X and resistance R_S. The resistance R in the unknown coil leg is an external resistor R_T in the standard coil leg in the afore-mentioned noninductive winding.

Probe-Type Liquid-Level Controller. A probe-type level control for liquid metals was developed for use on test loops. This type of level control utilizes three protected insulated probes and a system of relays which together operate solenoid valves. These valves maintain the liquid level by controlling the nitrogen pressure above the liquid. The probe type of level control has proved to be very satisfactory for use with nonradioactive liquid metals. A further modification utilizes a heavy current to clear the probe when inoperative because of a hanging-on effect. The time required to clear a probe can be shortened by using a greater current.

Resistance-Type Liquid-Level Indicator. Work is presently being done on a liquid-level indicator embodying the principle of a heated stainless-steel tube exhibiting a rapid rate of change in resistance when submerged in a liquid metal. This type of probe is not intended to be a precise indication of level. It is intended to be incorporated with at least two other similar types of probes, and with a suitable bridge circuit gives an indication of level between any two probes. It is expected that this principle of utilizing a heated probe will reduce the tendency of liquid to adhere to the surface of the probe and, consequently, a greater rate of resistance change will result, and the probe will have a shorter resistance time.

ELECTROMAGNETIC FLOWMETER

The rate of flow of a liquid metal in a tube of nonmagnetic material is readily obtained by means of the basic relationship of electromagnetics

$$e = Blv \times 10^{-8} \text{ volts}$$

where e, B, and v are mutually perpendicular vector quantities representing voltage, flux density, and the velocity of a moving electric conductor respectively, all in the cgs system of units.

A magnetic field perpendicular to a tube section is obtained by means of a permanent-magnet circuit. A voltage is generated according to the foregoing law by the flow of fluid, which in this case acts as a conductor moving through the magnetic field. This voltage is directly proportional to the rate of flow and is measured by means of a bridge-type electric circuit.

This type of voltmeter circuit balances a second voltage against that generated in the flowmeter. When the galvanometer is zeroed by adjustment of the potentiometer the voltage $e = IR_1$ is equal to the flowmeter voltage. Thus this circuit eliminates a possible error due to current flow in the flowmeter leads.

The pole faces of these flowmeters are unique in that they are fitted around the circular flow section of the test loop and are designed to give a maximum constant flux density at the center line of the magnetic gap. These flowmeters therefore do not restrict the liquid flow in any way. The width of the pole face in the direction of flow is held to a minimum in order to reduce the total weight of the meter. A tube-wall correction factor must be applied to account for the shorting effect of the conductive tube walls.

Meters that have been tested to date have shown reasonably good agreement between theoretical flow and the flow rate obtained by means of a calibrated orifice plate in the loop.

FLOW MEASUREMENTS USING ORIFICE PLATES

The flow in various loops carrying liquid metals has been measured by using orifice plates. The pressure taps for the orifice plates have been connected to sealed cans, and the previously mentioned liquid-level indicators have been used to maintain a level in these cans with an inert-gas atmosphere above the levels, with the inert gas then communicating to conventional pressure gages or mercury manometers. The orifice plates can be calculated to very close conformity with the actual flow. However, for really accurate work the quantity of flow should be measured with calibrated flowmeters, or by the use of weighing tanks. The use of weighing tanks is complicated because many of the liquid metals oxidize very readily upon exposure to air; so, consequently inert gas is required above the liquid level, and flexible connectors are required between the weighing tank and the balance of the loop.

PRESSURE MEASUREMENTS

On low-temperature loops the best test results have been obtained using stainless-steel Bourdon pressure gages mounted directly at the point where the pressure is to be measured. Where higher temperatures are encountered, an intermediate can is used with liquid-level controls in the can, with a gas line welded to the top of the can extending over some distance to the conventional Bourdon gage with stainless-steel internal elements. The connecting tubes should be as large as possible and should be heated where liquid metals are used that have a solidification point above normal room temperatures. A number of pressure readings have been taken using leak-tight gages, gage lines, and an intermediate can with an inert gas above a liquid level in it. The top of the can is finned to cause condensation of the liquid-metal vapors which then fall downward to the liquid level.

SUMMARY

Liquid-metal heat-transfer systems and liquid-metal nuclear-power cycles appear well on the way toward general usage by industry. With the successful development of liquid-metal circulating pumps to augment the already developed heat exchangers, proved principles of liquid-metal handling techniques, instrumentation, piping-expansion arrangements, and leak-detection apparatus, great strides can now be made toward the many applications of liquid-metal heat-transfer systems in the fields of engineering and industry.

The trend to higher-temperature liquid pumping for increased plant efficiency has been met by using hollow conductor motor windings in which liquid or gas is circulated, permitting positive cooling, reduced motor size, and design of completely enclosed packaged pump-motor units with fluid piston bearings for maximum dependability.

MANAGEMENT'S DEBT *to the* ENGINEER

By L. F. URWICK

CHAIRMAN AND MANAGING DIRECTOR, URWICK, ORR & PARTNERS, LTD., LONDON, ENGLAND. FELLOW ASME

INTRODUCTION

CALVIN Rice was Secretary of the Society from 1906 to 1934. The Management Division was founded in 1920, or precisely at the mid-point of his stewardship. This development of the Society's activities had his full support and approval. He was largely responsible for the publishers' decision to issue Taylor's "Shop Management" in book form. This is, however, the first occasion on which this memorial lecture founded in his honor and to further his ideals of increased understanding between engineers of different countries and the stimulation of the programs of meetings outside New York, has been assigned to a visitor from overseas primarily interested in management questions. It seemed appropriate, therefore, when your President did me the honor of asking me to select my own subject, that I should devote my talk to trying to survey, however inadequately and superficially, the inescapable debt which students of business management throughout the world owe to the engineering profession in the United States.

There must be those among the membership of the Society—and I believe there are many such among the younger men in all countries—who feel with me that in advancing the frontiers of this new body of knowledge which we term "management," in applying the objective spirit of scientific investigation fearlessly to social and human as well as to technical problems, lies our civilization's best hope of an escape from the dilemma which beats upon "our proud and angry dust" in these middle decades of the twentieth century. For that dilemma, however complex its outward manifestations, is in its essence simple.

THE CULTURAL REVOLUTION

In little more than two hundred and fifty years the scientific curiosity released by the Renaissance has resulted in a major cultural revolution. Man has acquired a control over his material environment quite unprecedented in the long history of the human race. It is but a century and a half since the wooden three-deckers, which broke the line at Trafalgar, the day that Nelson died in the *Victory's* cockpit, were utterly dependent on the skillful use of the wind and tide for propulsion and maneuver. Yet, within less than a hundred years, a British poet was writing of

> "The strength of twice three thousand horse that seeks the single goal
> The line that holds the rending course, the hate that swings the whole:
>
> The stripped hulls, slinking through the gloom, at gaze and gone again—
> The Brides of Death that wait the groom—the Choosers of the Slain."[1]

[1] Rudyard Kipling "The Destroyers."

The Calvin W. Rice Lecture, presented at the Fall Meeting, Chicago, Ill., September 8–11, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

And all that has happened in the half-century since those lines were written is merely an enlargement and a commentary on this tremendous access of power over material things. The "Spitfires" and the "Hurricanes" shooting the Luftwaffe to pieces over the smiling shires of Southern England, the American carrier forces that set a new pattern of sea warfare at Midway and the Coral Sea, the sudden blast of a yet more terrible force that reduced Hiroshima to pulverized dust almost in the twinkling of an eye—these things are of one piece.

Nor is the record all a tale of destruction. Even as I speak, there are construction gangs out in the wilderness in British Columbia harnessing water power to man's service on a scale undreamed of even twenty-five years ago. Then the job could not have been contemplated. For every man and every ton of supplies has to be flown in. This is only one of the tremendous projects to which engineers and businessmen in alliance are setting their hands in the land of great opportunity which marches with the Northern frontier of the United States.

Why then, with this tremendous power to our hands, with so much that is hopeful just over the horizon, should we be rent with faction; afraid, as many are afraid, of the very future of humanity as a species?

For a very simple reason. This new-found power over material things, these gifts which engineering above every other profession has placed within our reach, are not unconditional. The price of power is understanding, the insight to use it aright. And, as every engineer knows, a culture dependent on power-driven machinery has its own postulates. Above all, the proper, the effective use of modern machinery demands of men an intricacy of co-operation, a refinement of social discipline, such as they never before have contemplated. All around us lies the evidence of this truth.

Less than a century ago the farmer's wife went into town to do her shopping by the local carrier's cart. If she were a trifle late it would wait patiently at the cross-roads while she panted up the lane. It could make up the time on the road and, if it didn't, it was unimportant. To-day she may use a railway. And the social inconvenience of even slight delay with a train carrying two or three hundred people from A to B cannot be tolerated. She must be at the depot in time to catch her train or it will go without her. A railway schedule is a set of rules for imposing social discipline, rules supported by immediate sanctions. As the toll of death on the highways bears witness we have scarcely begun to solve the problems of social discipline set by the automobile.

A factory is still legally a workshop—a shelter to which workers repair to exercise their individual skills. Law always tends to lag somewhat conspicuously behind the facts. As every production engineer knows, a modern factory is nothing of the kind. It is a single integrated machine in which individual effort counts for very little save in so far as it is built into the whole. It is a very intricate machine planned in great detail, in which any deviation from plan, however trivial, causes losses and excess costs out of all proportion greater than the incident which gives rise to them. If men are to work success-

fully with these highly geared machines there must be an intricacy and precision of social discipline which are something quite new in human experience.

But our ability to meet this challenge, to develop the social skills which a mechanized economy so imperatively demands, appears not only to be failing to increase; as far as the evidence goes, it is decreasing. Much the most objective and fundamental piece of research which has been directed to such problems in the lifetime of the reader is the series of inquiries known as the Hawthorne experiments. To be sure they have issued in a vast superstructure of statistical analysis and theoretical exposition on an extremely narrow experimental basis. But the man who directed the whole inquiry, the late Prof. Elton Mayo, was no brash speculator. He had the skepticism of the true scientist to an exceptional degree and stated his generalizations in the most careful phrases. Nevertheless as to his broad conclusions there is no room for doubt:

"The typical industrial community of today is an adaptive society composed of individuals of varied origins . . . . . Difficulties of relating themselves to others and consequent solitariness and unhappiness characterize many of these people. . . . . Groupings frequently form in an attitude of wariness or hostility to other groups . . . . . (Digest) If our social skills (that is our ability to secure co-operation between people) had advanced step by step with our technical skills, there would not have been another European war."[2]

SOCIETY NEEDS REORGANIZATION

Yet to meet this critical, this urgent situation which faces us all—how to organize our societies so that the inescapable demands of power-driven machinery shall not overwhelm us and issue in an orgy of mutual destruction, a Gotterdammerung of our civilization—we have, seemingly, only the political concepts of an outmoded yesterday, ideas of organization which are little more than the obsolescent mental equipment of a handicraft age. Yet, as Herbert Spencer observed over a century ago:

"Socially as well as individually organization is indispensable to growth; beyond a certain point there cannot be further growth without further organization."

An American economist put the issue quite clearly before the first world war:

"So far is the machine process from having yet recast the principles of industrial management, as distinct from technological procedure, that the efforts inspired in responsible public officials and public-spirited citizens by this patent discrepancy have hitherto been directed wholly to regulating industry into consonance with the antiquated scheme of business principles, rather than to take thought how best to conduct industrial affairs and the distribution of livelihood in consonance with the technical requirements of the machine industry."[3]

The way of escape from this dilemma is not easy. Research into material things, in the physical sciences, yields immediate and obvious dividends; so that the new wealth which power-driven machinery made possible has been poured back unstintingly into metallurgy, engineering, electricity, and so on. The results of discoveries in these fields are applied readily, if not indeed greedily, immediately they are available By contrast, research in the social sciences is a far more remote and less favorable prospect. We have only to reflect that psychology, the science of human behavior, on which all exact knowledge in this field ultimately must depend, has only begun to emerge from a branch of speculative philosophy into a modern inductive and experimental study within the past three quarters of a century. The problems of social or group behavior are, of course, far more complex and resistant to measurement, than are those of individual behavior.

Moreover, the results of developments in the social sciences are only applied slowly and with great difficulty. Custom, tradition, determine our expectations of how others will behave and our own norms of conduct. They are not only the cement which holds our societies together, but also which makes human co-operation possible. The social patterns which derive from them are the basis of that satisfactory social living which is one of the deepest needs of the human spirit. Man is a gregarious animal. It is not surprising that we regard originality in social thinking with the gravest suspicion, that epithets such as "heterodox" and "radical" are terms of abuse, that social invention only makes any impress on established thinking at the speed of water dropping on a stone.

For these reasons there is not only a vast and dangerous unbalance in our knowledge about our human problems, there is a great and perilous delay in applying exact knowledge to social organization, even where it is available.

Nor must we overlook the effect of these tendencies on the minds of those best qualified to help us to meet our current difficulties, those in positions of leadership. They face a double temptation. An increasing proportion of the individuals in such positions are scientifically trained. On the one hand this inclines them to push their own particular methodology beyond the point where it has validity. But, on the other, it makes them aware of the rigorous character of scientific criteria, of the limitations of ordinary human judgment, and of how frequently they are compelled to discharge practical responsibilities for which they have little qualification save the valor of ignorance.

Opportunities of evading such responsibilities by laying the burden on the shoulders of some "expert" or other are extremely seductive—the modern equivalent of the sirens against whose charms earlier mariners took such elaborate precautions. And, unlike those ladies (the evidence as to their sex is inconclusive, but I am far too human to say neuters) the "expert" is not always a passive factor in the situation. He is often too willing, for ordinary human reasons to which he fails to apply his rigorous analysis of the behavior of others, to wear the cloak of a little brief authority; it conceals his nakedness of exact information on the subject in question.

There is no more pathetic spectacle than the specialist turned executive who uses the skepticism, so proper in one of the physical sciences, his awareness of the limitations of exact knowledge, as an excuse for evading the responsibilities which life has laid upon him. The point has been charmingly expressed by the Spanish philosopher, Ortega y Gasset:

"Life cannot wait until the sciences may have explained the universe scientifically. We cannot put off living until we are ready. The most salient characteristic of life is its coerciveness: It is always urgent 'here and now,' without any possible postponement. . . . . If the physicist had to live by the ideas of his science, you may rest assured that he would not be so finicky as to wait for some other investigator to complete his research a century or so later. He would renounce the hope of a complete scientific solution, and fill in, with approximate or probable anticipations, what the rigorous corpus of physical doctrine lacks at present, and in part always will lack."[4]

RESEARCH IN THE SOCIAL SCIENCES

If my analysis is correct, we face a dual problem. We must restore the balance of our knowledge. We must learn to push

[2] "The Social Problems of an Industrial Civilization," by Elton Mayo, Harvard University Press, Boston, Mass., 1945, p. 33.

[3] "The Instinct of Workmanship," by Thorstein Veblen, The Macmillan Company, New York, N. Y., 1914, p. 342.

[4] "Mission of the University," by Paul Kegnan, London, 1946, p. 146.

forward research in the social sciences with the same enthusiasm, the same outpouring of resources, which we have hitherto devoted almost exclusively to the physical sciences. At the same time we must recognize that exact knowledge is a plant of slow growth. While it is developing we have to preserve social order, both nationally and internationally; we have to devise methods of introducing social change where it is proved desirable, despite custom and tradition, without disturbances which render organized life impossible. That is primarily a question of personal leadership, of discovering and developing individuals with the knowledge, the character, the sense of service to their fellow men, which will convince those they administer to of the wisdom of allowing them to lead. We have to redesign our political and social thinking to accord with the postulates of a culture based on power-driven machinery; at the same time we have to keep the ship of organized society afloat.

To quote Ortega y Gasset once more:

"Society needs good professional men—judges, doctors, engineers . . . . But Society needs before this, and more than this, to be assured that the capacity is developed for another kind of profession, the profession of governing."[5]

The group of engineers who, with the support of this Society, first attempted to apply the intellectual methods of science—the tools of definition, analysis, measurement, experiment, and proof—to questions of business management, were the first men in the world to approach this wider problem which I have outlined. They were in fact attempting to take thought "how best to conduct industrial affairs and the distribution of livelihood in consonance with the technical requirements of the machine industry." And they were facing up to both aspects of the problem. They were carving out of ignorance and uncertainty a new branch of human knowledge; they were equally clear that it was a part of their responsibility to hold at arm's length while they did so the chaos that is apt to follow too sudden change.

They were aware of the need for dealing with the problem of co-operation. Toward the end of his life, before the Congressional Committee of Inquiry in 1912, Frederick Winslow Taylor laid down two basic conditions "without which scientific management cannot be said to exist in any establishment." *First* of these two conditions he placed the development of a common purpose—"both sides take their eyes off the division of the surplus as the all-important matter, and *together* turn their attention toward increasing the size of the surplus."[6] They were equally well aware of the need for more research in the social sciences; "There is another type of investigation," wrote Taylor, "which should receive special attention; namely, the accurate study of the motives which influence men."[7]

If they had not been—and Taylor either failed to encounter, or to recognize the significance of, the early work in industrial psychology contributed by Walter Dill Scott, Hugo Munsterberg, and others—there was the amazing fact that one of them, Frank Bunker Gilbreth, happened to fall in love with a girl who was a psychologist by education, a teacher by profession, and a mother by vocation. I know of no occurrence in the whole history of human thought more worthy of the epithet "providential" than that fact. Here were three engineers—Taylor, Gantt, and Gilbreth—struggling to realize the wider implications of their technique, in travail with a "mental revolution," their great danger that they might not appreciate the difference between applying scientific thinking to material things and to human beings, and one of them married Lillian Moller, a woman who by training, by instinct, and by experience was deeply aware of human beings, the perfect mental complement in the work to which they had set their hands.

Long since she has taken her place in her own right among the pioneers of management. This Society again showed its sympathy with the subject by making her one of its first woman members, and more recently, its first woman Honorary Member. Also recently, two of her children by their wit and their good writing have made her name famous in all quarters of the globe, and Mrs. Myrna Loy Gilbreth has presented the movie public with a dual personality which taxes its powers of discrimination. But I do not think she will blame me for the suggestion that the greatest thing she has ever done, and she has done many great things, was to marry Frank and through that marriage to contribute the influence of the young science of psychology to the nascent management picture.

This triumvirate, or rather quadrumvirate, was too fully alive to the importance of leadership. One of Henry Lawrence Gantt's three books carries the title "Industrial Leadership." He chose this phrase as the caption of his first lecture in the Page Lecture Series at Yale in 1915, because he wished to emphasize leadership "over all other elements that make for industrial progress."[8] Business has taken its time in taking that lesson to heart. It was not till approximately 1945—thirty years later—that interest in what is called executive development, treating the supply of future leadership as a problem of major importance and organizing for it deliberately, attracted general attention even among the more progressive corporations.

This would not have surprised Frederick Winslow Taylor, though it might have irritated him. He also was deeply sensitive to the difficulties of introducing changes in social thinking. Time after time in his later years, when he had become the first professional management consultant, he returned to the point. For instance, "time, and a great deal of time, is involved in a radical change in management, and . . . . . in the case of a large works if they (the Directors) are incapable of looking ahead and patiently waiting for from two to four years, they had better leave things just as they are, since a change in system involves a change in the ideas, point of view and habits of many men with strong convictions and prejudices, and . . . this can only be brought about slowly and chiefly through a series of object lessons, each of which takes time."[9] Despite the storm of criticism which his ideas provoked among the leaders of organized labor, it remains a fact of record, which should not be forgotten, that there never was a strike in any plant where he himself was operating.

It may, and has been urged however, that to claim that this small group was in fact precipitating a revolution in our ideas about government is going too far. Business management is not government; it moves in a different realm of discourse. It is true, however, that Taylor himself and other distinguished authorities who have followed him, notably Henri Fayol and Mary Parker Follett, have been convinced that if valid principles are established bearing on business organization they must be equally applicable to conducting the affairs of a muncipality, a state or an empire. In Great Britain, for instance, business management and public administration are often spoken of as contrasted callings involving different techniques. However, this may well be an example of what the French call *deformation professionelle*—a phrase which it is difficult to translate, but which may be rendered freely as occupational paralysis of the cerebellum.

In the words of Henry Laurence Gantt, "administration

[5] Reference 4, p. 45.

[6] "Scientific Management," by F. W. Taylor, Harper & Bros., New York, N. Y., 1947; "Testimony," pp. 29, 30.

[7] Ibid., "The Principles of Scientific Management," p. 119.

[8] "Industrial Leadership," by H. L. Gantt, Yale University Press, 1916, p. 1.

[9] Reference 6, "Shop Management," p. 130.

means administration of human affairs, and the one common element in all enterprises is the human element."[10] It is possible that the claim by other vocations that management knowledge is not applicable in their special circumstances is only a variant on the old alibi "my business is different," which was so serious an obstacle to the diffusion of an understanding of management in industry in its early stages. If we turn to the only other art, with a scientific foundation, which, as in management, is primarily concerned with human beings, namely the art of medicine, it is difficult to imagine how it could have made satisfactory progress on a basis of vocational distinctions. To be sure it recognizes certain occupational diseases, but their cure is derived from a general knowledge of medical practice and not from the exclusive study of particular callings. Artists' amnesia, professors' paranoia or the psychopathology of politicians do not suggest fruitful lines of inquiry.

BUSINESS IS BASED ON CO-OPERATION

Certainly a business enterprise is a form of human co-operation for economic purposes, a society with a special object within the larger society of the nation. To manage it is to govern it just as surely as conducting the business of a municipality or a state or an empire is to govern it. Indeed if, following Mr. Peter Drucker, we agree that the business corporation is the typical institution in our modern society, the problem of governing it well may not only be analogous to but more important to the community than the problem of governing states or empires. I can see no major distinction, and I have had some experience of both, between the problems arising in the government of business and in the business of government.

During the course of the Congressional inquiry already mentioned, Taylor was asked, "You do not claim a monopoly on scientific management?" His reply should be hung framed in every office where men are concerned with the subject. "I should say not. My gracious, I do not believe there is any man connected with scientific management who has the slightest pride of authorship in connection with it. Every one of us realizes that this has been the work of 100 men or more, and that the work which any one of us may have done is but a small fraction of the whole. This is a movement of large proportions, and no man counts for much of anything in it. It is a matter of evolution, of many men, each doing his proper share in the development, and I think any man would be disgusted to have it said that he had invented scientific management, or that he was even very much of a factor in scientific management. Such a statement would be an insult to the whole movement."[11]

Those words were spoken forty years ago. Since, many thousands of men and women all over the world have devoted their lives to the subject. There has been an international committee for scientific management since 1925. Its Secretary, my old friend and colleague, Mr. de Haan, has been giving invaluable service to the management movement for the past quarter of a century.

PIONEERS IN MANAGEMENT

I have mentioned so far four people—Taylor, Gantt and the Gilbreths, all members of this Society, whose names were conspicuous in the early days of the movement. But, I think it accords with the spirit of Taylor's observation which I have just quoted and with our general knowledge of the way in which new categories of knowledge develop, to suggest that the contribution of these individuals as inventors and initiators was less important than the fact that they focused and organized tendencies in human thought which were already in the atmosphere, when they started on the work of their lives. The Society placed all of us in its debt when it provided a ready platform for management concepts. F. W. Taylor presented four papers to the Society on such subjects and was its President; H. L. Gantt eleven such papers; F. B. Gilbreth four; and Lillian Gilbreth eight up to 1949. But I believe that the American engineering profession rendered the world and its future an even greater service by providing a climate of professional opinion in which what I may perhaps describe as extracurricular ideas could take root and germinate. It is this breadth of vision, this determination not to confine their interest within too narrow technical bounds, for which the world owes that profession its undying gratitude.

We are celebrating the centenary of the American Society of Civil Engineers, founded in November, 1852. Its first circular issued at that time reveals this spirit. It welcomes as members not only all categories of engineers, but architects and "other persons who, by profession, are interested in the advancement of science." It expresses the hope that "the bond of union established by membership in the same society, seeking the same end, and by the same means, will do much to quiet the unworthy jealousies which have tended to diminish the usefulness of distinct societies formed heretofore by the different professions for their individual benefit."

After March, 1855, the ASCE was in abeyance until October, 1867, partly because of the Civil War. But at the first annual convention of the reconstituted society held in 1869, John B. Jervis, an honorary member of the society, struck a similar broad note:

"No skill," he said, "in forming lines and levels and in devising structures, will complete the education of an engineer without an intelligent capacity for conducting business. This is an important item in his education and indispensable to a successful practice . . . . . Some people suppose an engineer, as a matter of course, knows nothing about business management. An absurd mistake. No profession more needs a thorough business qualification . . . . . I think I am fully warranted in the opinon, that the training and practice of an engineer should make him peculiarly eminent as a businessman, not less than skilled in erecting and designing works in his profession."

Similarly, when THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS came to be formed, A. L. Holley, CE, one of the founders and an Honorary Member in Perpetuity took the chair at the preliminary meeting held in New York in February, 1880. On this occasion he said:

"In the American Institute of Mining Engineers and in the Iron and Steel Institute of Great Britain, anyone is qualified who is engaged in mining and metallurgy. The advantages of the association of businessmen with engineers in these societies are notorious; these advantages are not only large membership, and hence large incomes to devote to publications and illustrations, but they lie chiefly in the direct business results of bringing professional knowledge, capital, and business talent together under the most favorable circumstances."

From the very beginning that spirit of accommodation was manifest in the proceedings of the Society. F. W. Taylor's first paper on a management subject, "A Piece-Rate System," was read in 1895. But this was merely regarded as a contribution to the prevailing interest in methods of wage payment, somewhat to Taylor's disgust. It was only in 1903, with his "Shop Management," which owed much to the encouragement of Calvin Rice, that he really focused the attention of his fellow engineers on his management thinking. At the conclusion of that paper he acknowledged the contributions of eight men "among the many improvements for which the originators will probably never receive the credit which they deserve."

[10] Reference 8, p. 9.
[11] Reference 6, "Testimony," p. 282.

Among these eight were Oberlin Smith whose "Mnemonic System of Order Numbers" was presented at the Society's third meeting at Altoona, Pa., in 1881. He was one of the original members and a frequent contributor in the eighties. Most of his papers had a management angle, for instance "Experimental Mechanics," a plea for more research, at the second meeting in 1881. "The Systematic Preservation of Drawings," in 1882, and the "Graphical Analysis of Reciprocating Motions," in 1890, "Inventory Valuation of Plant," in 1886, and "Intrinsic Value of Special Tools," in 1887. He was elected the Society's ninth President in 1889. His paper on "Order Numbers," established one of the earliest international links in management.

In 1889, Messrs. Emile Garoke and J. M. Fells published their "Factory Accounts," one of the earliest management books to appear in Great Britain; they reprinted Oberlin Smith's paper in full. It may be noted that the two authors were respectively an engineer and an accountant. In the Britain of that date when the commercial and engineering departments of most factories usually lived on opposite sides of a heavily defended frontier, for members of these two professions to collaborate in a book was for Montagu and Capulet not only to marry but to have a baby.

Contemporary with Oberlin Smith was Henry Robinson Towne who was president of the Yale and Towne Manufacturing Company and preceded Smith by one year as the Society's eighth President in 1889. He was elected an Honorary Member in 1921. In 1884, he presented a paper on "A Drawing Office System," at the Society's ninth meeting. On this subject he had been preceded by C. T. Porter who presented "A New Method of Keeping Mechanical Drawings," at the third meeting in 1881.

In 1886, Towne followed up with his famous paper on "The Engineer as an Economist." This was a direct challenge to those engineers who felt that the Society should confine itself strictly to technical subjects and that management problems lay outside its proper field of interest. "The true function of the engineer," said Towne, "is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically." Between 1887 and 1912, he presented five further papers on management subjects.

One of the eight, Taylor selected for special recognition. He wrote:

"The card system of shop returns invented and introduced as a complete system by Captain Henry Metcalfe, U.S. Army, in the Government shops of the Frankford Arsenal, represents another such distinct advance in the art of management. The writer appreciates the difficulty of this undertaking as he was at the time engaged in the slow evolution of a similar system in the Midvale Steel Works, which, however, was the result of a gradual development instead of a complete well thought out invention as was that of Captain Metcalfe."[12]

Captain Henry Metcalfe, an officer in the Ordnance Corps, was the inventor of the magazine system of loading rifles; his clip, being of wood, was rapidly superseded. While in charge of the Frankford Arsenal he initiated a system of production control which was, as far as I am aware, the first example of the thorough application of the unit document or card principle to the paper work of industry. He presented a paper to the Society in 1886, entitled "A Shop Order System of Accounts." His book on the subject appeared in 1885, and is an early management classic.[13]

I should like to add that when I applied for this book, published 67 years ago, at the New York Public Library, at 5:30 on a recent Sunday afternoon, it was on my reading desk within two minutes. This fact seems to me a remarkable tribute to the efficiency both of the library and of the card system which Metcalfe frankly borrowed from library practice and applied to production control. His paper to the Society was not included in the "complete list of papers in the Transactions . . . . . dealing with industrial management" issued as Appendix II of the Report on "The Present State of the Art of Industrial Management," presented by the Society's Subcommittee on Administration in 1912.

I hope you will regard as proved my conviction that the attitude and outlook of the American engineering profession, when Taylor was still quite a young man, were already concerned with problems of management, had laid the foundations of certain lines of inquiry, and were predisposed to welcome further developments. To say this is not to detract one iota from the genius and the achievement of the four persons whom I have described as the great quadrumvirate. Indeed it seems to me to raise their contribution to a higher power, as expressing and focusing a widely felt, but dimly appreciated, need of their time. What they did was to seize the opportunity thus presented to them. They supplied, in their turn, a whole series of new and stimulating ideas, above all a unifying concept, a philosophy which gave the study of management definition a tremendous impetus. But, if the opportunity had not been there, their ideas might well have been dissipated and frustrated in vain struggles for a hearing of any kind, their energy wasted in clambering onto any sort of platform rather than in taking thought as to what they should say when they got there. That has been, too often, the fate of original minds in a world not markedly sympathetic to originality.

It is indeed difficult to realize in these later days when, in the United States at all events, management is an established subject and all recognize its importance, either the quality of that support or what the sympathy of men like Towne and Oberlin Smith, Horace K. Hathaway, and James Mapes Dodge must have meant to the pioneers. Roy Stannard Baker, reporting the hearings in the Eastern Rates case, of 1910, wrote:

"As one sober, hardheaded businessman after another testified as to what had been accomplished in his plant, ... the spirit of incredulity changed to one of deep interest. Another factor in carrying conviction to the hearers was the extraordinary fervor and enthusiasm expressed by every man who testified. Theirs was the firm faith of apostles: it (scientific management) was a philosophy that worked and they had the figures to show it. "This," said Mr. Commissioner Lane to one of the witnesses," has become a sort of substitute for religion with you."[14]

It was the general attitude of the American engineering profession which made possible the generation of that profound interest and confidence in a small but vital group. And to those who believe as I do, that in the development of scientific thinking about government lies the only hope of humanity today, the significance of that attitude *at the beginning of a new order of thinking*, was incalculable. In words used in another context "Some altars are safe; some debts will never be dishonoured. . . . There remains the stark simplicity of Terence—'In truth they have deserved to be remembered of us.' "[15]

SECOND GENERATION OF MANAGEMENT

Of course there was a reaction. In every profession there are men who believe with all sincerity that the only way to keep

[12] Reference 6, "Shop Management," p. 202.

[13] "The Cost of Manufactures and the Administration of Workshops, Public and Private," by Henry Metcalfe, 1885.

[14] *The American Magazine*, March, 1911, quoted F. B. Copley, "Frederick Winslow Taylor—Father of Scientific Management," Harper & Bros., New York, N. Y., 1923, p. 8.

[15] "The Wandering Scholars," by Helen Waddell, Constable & Company, London, seventh edition, 1934, pp. 220, 221.

the milk of the world pure is to sterilize the cow. The most scientific training is no guarantee against vocational provincialism; there are always would-be martyrs looking for a parish pump to die with their backs to it. Taylor's paper on the "Principles of Scientific Management," was not welcomed, despite the fact that he was a past President of the Society.

But this opposition was well handled by a new generation of engineers who appreciated the importance of the management movement. Ever since, the Society's records have been starred with the names of engineers who also have made outstanding contributions to the theory and/or the practice of management. Among its living Honorary Members, in addition to Lillian Gilbreth, are William L. Batt, Harold V. Coes, Ralph E. Flanders, and Dexter S. Kimball,[16] all of whom have held office as President, and Herbert Hoover. Among former officers appear Morris L. Cooke, Horace P. Liversidge, and Robert B. Wolf.

Papers on management subjects appear under eighteen headings in the most recent index of the Transactions. In the 1940–1949 period the caption "Management" by itself included 46 papers, an average of just over five a year. The Management Divison attracts the interest of a greater number of members than any other.

While this happy result is a product of the enthusiasm and interest of the membership as a whole, there is one more name which must be mentioned before I close—that of the late Leon Pratt Alford. He was Secretary of the Subcommittee on Administration which in 1912, prepared the report on "The Present State of the Art of Industrial Management," already mentioned; at that time he was editor of the *American Machinist*. On the formation of the Management Division of the Society in 1920, he became its first chairman. In 1922, he conceived the idea of following up the original report with a second report to the Annual Meeting of the Society on "Ten Years' Progress in Management." He presented a third report in 1932, and was already well advanced in his preparations for a fourth report in 1942, when he died suddenly in January of that year. The work was picked up immediately by the Executive Committee of the Management Division which nominated a Report Committee under the Chairmanship of Dr. Lillian Gilbreth. The report was completed along the lines of Mr. Alford's original plan. A fifth report will be published shortly.

These first four reports, covering a period of more than thirty years, and all of them prepared in some degree under the unifying influence of a single mind deeply versed in management literature and practice, form a unique contribution to our knowledge of the subject. Many of us in other countries have viewed with great admiration the tremendous vigor with which the study and practice of management has been developed in the United States over this period. But the task of trying to keep ourselves informed has sometimes been intimidating. As the provision of educational facilities in management has expanded, it has sometimes seemed to us that the publication of a comprehensive textbook at fairly frequent intervals has become almost an occupational disease with American professors of business administration. And, putting aside the fact that there is as yet little common agreement as to the pattern into which management knowledge should be organized, these textbooks often appear to be aiming at the principle of "bigger and better elements." I know few of them which do not contain a large proportion of redundant matter, redundant because it already has been stated effectively elsewhere. I know none of them light enough to be carried conveniently in an ordinary brief-case.

Amid this welter of ponderous volumes, these decennial reports, brief, authoritative and yet omitting nothing of real importance, have been the most valuable of guides. They are of a piece with what I have always regarded as Alford's other major contribution to management knowledge—the most distinguished series of handbooks, beginning with "Management's Handbook," continuing as "The Cost and Production Handbook," which in its turn, developed into "The Costing Handbook," and "The Production Handbook," most of which he designed and edited for The Ronald Press. He was made an Honorary Member of the Society in 1941. With Lillian Gilbreth he was a bridge between the early pioneering days and the stupendous development of the subject we see around us today.

Management in the United States has grown up. It has its own organizations—the American Management Association, The Society for the Advancement of Management, The National Industrial Conference Board. No doubt there are questionings and searchings of heart among some members of this Society as to whether it is right in continuing to treat the Management Division as one of its major activities. It is not for me, officially, I believe, an "unregistered alien" to venture an opinion on so delicate, so domestic, a matter.

AMERICA'S PLACE IN THE MANAGEMENT MOVEMENT

On behalf of my fellow students of management in all other countries I know I can say with absolute truth how deep is their gratitude to the United States for fostering and fathering this great movement in human thought. As I have tried to show, it owed almost everything in the beginning to the support and vision of the American engineering profession. They would view with the deepest regret and dismay any signs that that profession was less interested in the subject or was abating one jot of its enthusiasm and leadership.

They would feel that that was not only a hurt to management all over the world, but a loss to engineering in the United States. The most far-reaching inquiry into engineering education that the world has yet known was staged in this country. The report of that inquiry, usually known as the Wickenden Report, states the following important conclusion: If the engineer is to play his part as a member of society in the twentieth century he must retain all the special qualities of the engineer but "add to them a wider humanism." Management study is the obvious avenue to that "wider humanism."

So, to those members of the Society who believe in expanding and strengthening the work of the Management Division, I would say "stick to your guns"—not only for the sake of its splendid past, for which we are all in your debt, but still more for the sake of your own future. For without better management and a wider appreciation of management principles in the Western democracies, the outlook for our civilization is bleak.

And to the younger men I would add, be under no illusions. Scientific Management is the hard way, the long haul. The world infinitely prefers its ideologies, the modern alibi for a theory, its superstitions, its petty politics. It has been well said that "The price of freedom is eternal vigilance"; the price of social insight which will stand the test of scientific analysis is a continual succession of men and women who are ready to fight for Truth and, if necessary, to die for it.

MANAGEMENT IS AN ART

Management, government, is not a science: It is difficult to contemplate that it will ever become a pure science. It is an art. But it is an art which can be practiced in one of two tempers. There is the temper of the old-time craftsman who was merely apprenticed to a master, who learned his craft unsystematically by trial and error and practiced it in the half-light of

(*Continued on page 386*)

[16] Dean Kimball died on Nov. 1, 1952.—Editor.

An ANALYSIS *of the* *Pivoted-Pad* JOURNAL BEARING

By JOHN BOYD[1] AND ALBERT A. RAIMONDI[2]

RESEARCH LABORATORIES, WESTINGHOUSE ELECTRIC CORPORATION, EAST PITTSBURGH, PA.

INTRODUCTION

THE hydrodynamic wedge, the principle of which was first set forth by Reynolds, is automatically made possible in the plain journal bearing by the physical necessity of constructing the journal somewhat smaller in diameter than the bearing.

Since no such fortunate situation exists in the case of flat rubbing surfaces, special designs are necessary before the wedge principle can be adapted to plane sliders or to thrust bearings.

When Kingsbury and Michell succeeded in applying this principle to thrust bearings by the introduction of pivoted pads, it was only natural that the highly satisfactory results which they obtained should suggest that similar advantages could be obtained by applying such pads to journal bearings themselves.

However, since plain journal bearings already incorporate the features of the hydrodynamic wedge, it is evident that the application of pivoted pads, in this case, will not produce the degree of improvement possible from a similar application in thrust bearings.

Nevertheless, pivoted-pad journal bearings have certain characteristics which make their use advantageous. It is the purpose of this paper to compare the performance of pivoted-pad and of plain journal bearings on the basis of theoretical calculations and to attempt to point out some of the advantages and disadvantages of each type.

TYPES OF LOADING

Although pivoted-pad journal bearings are used frequently as vertical guide bearings where the load may act in any direction, there are many types of applications where the direction of the load is known. Under these circumstances, one has

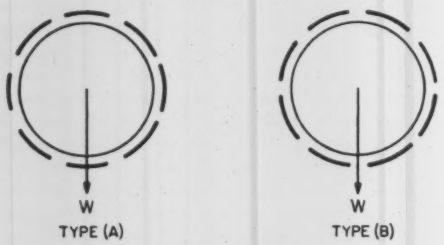


FIG. 1 TYPES OF LOADING

the option of arranging the pads in various configurations with respect to the applied load and it is not at all necessary that the pads be of equal size, or that they be spaced equally. However, since the usual practice is to construct all pads alike and to space them uniformly around the circumference, the present discussion will be limited to bearings of this design.

If the number of pads is large, one senses intuitively that it makes little difference whether the line of action of the load passes through the center of one pad or lies midway between two pads as indicated in Fig. 1. However, if the number of pads is small, appreciable differences in performance result as will be shown later. For this reason two types of loading, type A and type B, as indicated in Fig. 1, will be considered.

NOMENCLATURE

In developing the expressions used in this paper, the following nomenclature was employed; some of the terms are shown diagrammatically in Figs. 2, 3, and 4:

W = total load, lb
W_i = radial load on individual pad, lb
W_m = radial load, maximum load pad, lb
U = peripheral speed, ips
N = speed, rps
R = journal radius, in.
R' = bearing radius, in.
C = radial clearance = $R' - R$, in.
L = axial length of pad, in.
B = length of pad in direction of motion, in.
n = number of pads
e = journal eccentricity, distance between journal and bearing centers, in.
ϵ = eccentricity ratio = e/c
μ = viscosity of lubricant in reyns, lb sec/in^2
h_p = film thickness at pivot position, in.
h_1 = film thickness at inlet edge of pad, in.
h_2 = film thickness at outlet edge of pad, in.
h_n = minimum film thickness of bearing = h_2 for maximum load pad, in.
P = load per unit projected area = $W/2RL$, psi
P_m = load on maximum load pad per unit area of pad = $\frac{W_m}{BL}$, psi
P_i = load on individual pad per unit area of pad = W_i/BL, psi
H = total power loss, hp
H_i = power loss for individual pad, hp
Q_i = lubricant flow across individual pad, cu in. per sec
Δt_i = temperature rise of lubricant across individual pad, deg F
Δt_m = temperature rise of lubricant across maximum load pad, deg F
Δt = total temperature rise of lubricant for plain journal bearing, deg F
θ = angle from line of centers to pad pivot, deg

METHOD OF ANALYSIS

Fig. 2 shows the displacements and film pressures involved for a pad located at some generalized angle θ, with the line of centers of the journal and the bearing and for a given eccentricity ϵ, of the journal.

[1] Manager, Lubrication Section. Mem. ASME.
[2] Research Engineer. Jun. ASME.

Contributed by the Power and Machine-Design Divisions, and the Lubrication Activity, and presented at the Annual Meeting, New York, N. Y., November 30-December 5, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

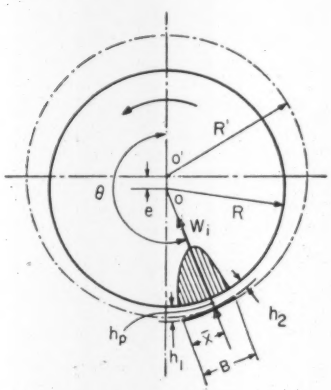


FIG. 2 DIAGRAM FOR INDIVIDUAL PAD

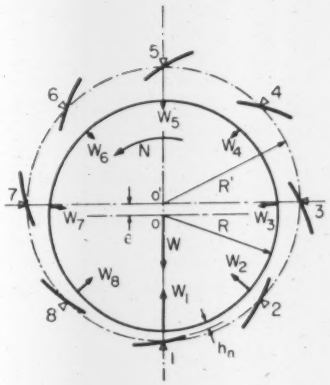


FIG. 4 TYPICAL LOAD DIAGRAM, TYPE A LOADING

FIG. 3 EQUIVALENT PLANE-PIVOTED SLIDER

Taking the bearing radius R' to be the distance between the bearing center and the bearing surface of the pad at the pivot position, the radial clearance C is equal to $R' - R$, where R is the radius of the journal.

Following the usual reasoning employed in journal-bearing problems, the film thickness h_p, along the radius through the pivot can then be written

$$h_p = C(1 + \epsilon \cos \theta) \quad [1]$$

where $\epsilon = e/C$.

If it is now assumed that the curvature of the pad is such that the film thickness is uniform when the pad is placed so that its radius passes through the journal center (this assumption will be discussed later) the film between the pad and the journal may be treated as that between a plane pivoted slider and a flat surface as in Fig. 3(*a*).

When motion takes place, the pad will pivot as in Fig. 3(*b*), and it can be shown that once the pivot position, as defined by $\bar{X}/B$ (where B is the circumferential length of the pad and $\bar{X}$ is the distance from the inlet edge to the pivot) is chosen, the ratio of the inlet film thickness h_1, over the outlet film thickness h_2, becomes known and remains constant for all conditions of operation. Thus if the pivot position is made the same for all pads, the ratio h_1/h_2 also will be the same for all pads.

By similar triangles, the outlet film thickness can be expressed in terms of h_p by the relation

$$h_2 = \frac{h_p}{A} = \frac{C(1 + \epsilon \cos \theta)}{A} \quad [2]$$

where

$$A = \left(\frac{h_1}{h_2} - \frac{h_1}{h_2} \cdot \frac{\bar{X}}{B} + \frac{\bar{X}}{B}\right)$$

With the proportions of the film now fixed, the pressure force W_i, on the journal produced by the lubricant between it and the pad can be shown to be given by the relation[3]

$$W_i = \frac{\mu U B^2 L}{C^2} C_W \frac{1}{(1 + \epsilon \cos \theta)^2} \quad [3]$$

where μ is the lubricant viscosity; U the surface speed; L the axial length of the pad; and C_W a factor which depends only on the proportions of the pad, B/L, and the position of the pivot, $\bar{X}/B$. The values of C_W used in the paper were determined from the work of Muskat and Morgan[4] and were chosen in such a manner as to give the maximum load capacity for a given B/L ratio. Using a similar analysis, the power loss H_i, resulting from viscous friction between the pad and the journal, can be shown to be given by the relation

$$H_i = \frac{\mu U^2 B L}{C} C_H \frac{1}{1 + \epsilon \cos \theta} \quad [4]$$

where C_H is a factor which again depends only on B/L and $\bar{X}/B$.

Similarly, the amount of lubricant Q_i, pumped through the space between the pad and the journal by the motion of the latter may be shown to be given by

$$Q_i = ULC C_Q(1 + \epsilon \cos \theta) \quad [5]$$

where C_Q is another factor which depends only on B/L and $\bar{X}/B$.

Assuming that all the work of friction H_i, goes into raising the temperature of the lubricant pumped through the film Q_i, the temperature rise of the lubricant Δt_i, in traversing the circumferential length of the pad can be shown to be given by

$$\Delta t_i = P_i C_T \quad [6]$$

where C_T is still another factor which depends only on B/L and $\bar{X}/B$.

TOTALS FOR ALL PADS

The load for each pad can be found by evaluating Equation [3]. In carrying this out for the present analysis, it was assumed that the pads occupied 75 per cent of the circumference or that

$$B = 0.75 \times \frac{\pi D}{n} \quad [7]$$

With the load for each pad determined, the total load for the bearing can be found by summing up the vertical components of each of the pad loads. Fig. 4 shows graphically the relative loads on each of the pads for the given eccentricity. Also shown are the relative inclinations of the pads and their respective outlet film thicknesses. The outlet film thickness for the most heavily loaded pad henceforth will be referred to as h_n.

It will be observed that if the pads are spaced equally and if eccentricity be taken in the direction of one of the pivots, the remaining pads will be oriented symmetrically with respect to the direction of the eccentricity; thus they will

[3] Compare similarity with equation [43], p. 77, "Lubrication," by A. E. Norton, McGraw-Hill Book Company, New York, N. Y., 1942.

[4] "The Lubrication of Plane Sliders of Finite Width," by M. Muskat, F. Morgan, and M. W. Meres, *Journal of Applied Physics*, vol. 11, 1940, p. 208.

have symmetrical values of h_1 and of h_2 and will exert symmetrical forces on the journal. Since the pad forces are symmetrical, their resultants will act through the center of the journal and be paralleled to the direction of eccentricity. Reasoning backward, it can be seen that the eccentricity of a pivoted-pad bearing with type A loading will be in the direction of the applied load. A similar argument holds for type B loading. This is not true for a plain journal bearing.

The total power loss H, for the bearing can be found by summing up the power loss for each pad as given by Equation [4].

As the flow around and between the pads will depend upon the construction of the bearing, no especial significance can be attached to a summation of flow for the various pads. The flow for the individual pads is mainly of interest since it is required to obtain the temperature rise of the lubricant for each pad.

In a similar manner, no particular meaning can be applied to a summation of the temperature rises for the various pads. The temperature rise of the most heavily loaded pad is of concern, however, since it is one of the critical factors associated with the bearing performance.

DISTRIBUTION OF LOAD BETWEEN PADS

Figs. 5 and 6 show the radial load on the individual pads plotted against the eccentricity ratio for an 8-pad bearing with type A and type B loading, respectively, and illustrate how the uniform radial-load distribution, which exists when the journal and the bearing are concentric, changes rapidly as the eccentricity is increased. When the eccentricity ratio exceeds a value of, say, 0.6, the radial loads on all pads except those close to the line of action of the load become insignificant. It is interesting to consider here that, while the eccentricity ratio of the type A loading cannot exceed unity, this is not true of the type B loading. This can be explained readily by noting that, in the first instance, when the journal is displaced in the direction of a pivot, the maximum displacement is limited by the radial clearance. In the second case when the load is directed between pivots, the tilting of the pads permits additional radial displacement.

In Fig. 7 the radial load on the most heavily loaded (maximum load) pad or pads (in the case of type B loading) is plotted against the eccentricity ratio for bearings with 4, 6, 8, and 12 pads. The curves show that the load on the bottom pad of the 4-pad bearing with type A loading is always greater than the total load carried by the bearing and that the ratio W_m/W, which is a measure of the degree of uniformity of the load distribution, is less for type B than for type A loading. The curves also indicate that, as the number of pads increases, the load distribution becomes more uniform since the most heavily loaded pad, or pads, take progressively less of the total load.

In line with the comments previously made on the possible eccentricity ratios for type B loading, the terminal points of the dotted lines show the maximum ratios possible for 4, 6, 8, and 12-pad bearings.

EFFECT OF TYPE OF LOADING ON LOAD CAPACITY

In the case of a pivoted-pad bearing designed to carry a load

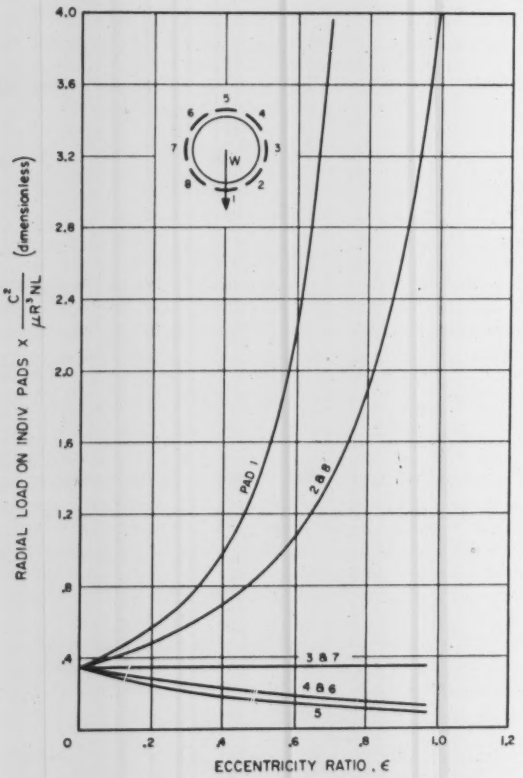


FIG. 5 VARIATION OF LOAD DISTRIBUTION WITH ECCENTRICITY RATIO, TYPE A LOADING
(Eight pads; $L/D = 0.3$, $B/L = 1.$)

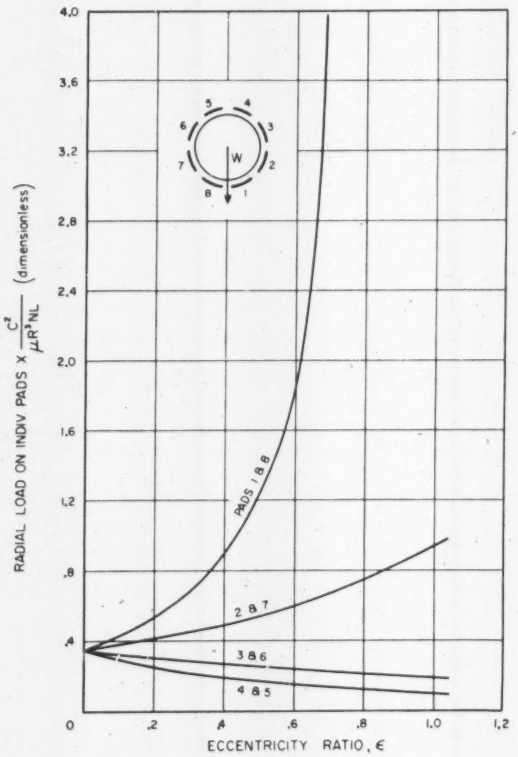


FIG. 6 VARIATION OF LOAD DISTRIBUTION WITH ECCENTRICITY RATIO, TYPE B LOADING
(Eight pads; $L/D = 0.3$, $B/L = 1.$)

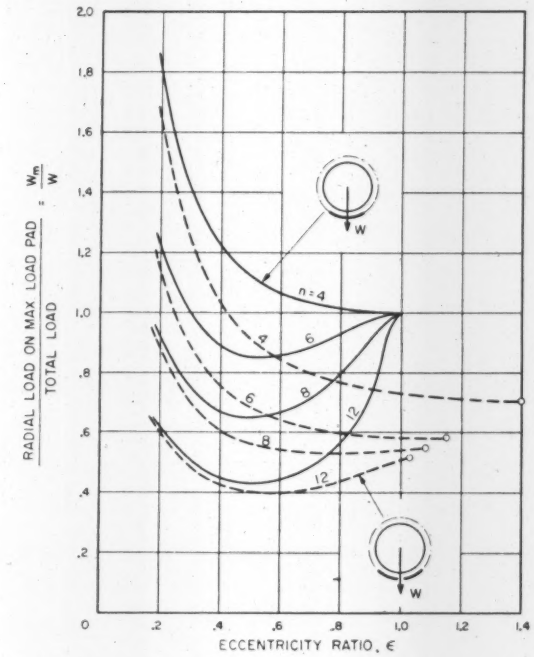


FIG. 7 PROPROTION OF LOAD ON MAXIMUM LOAD PAD VERSUS ECCENTRICITY RATIO

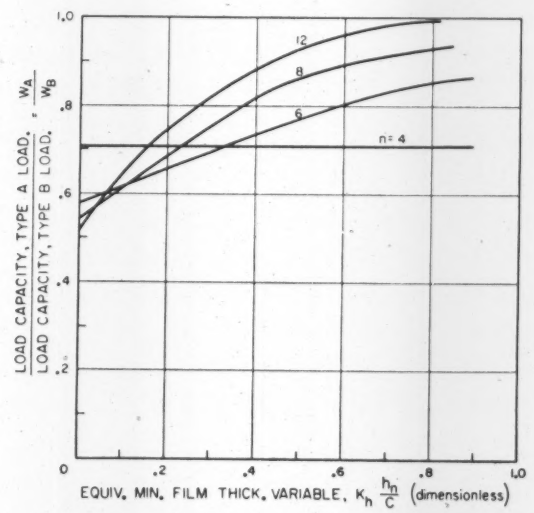


FIG. 8 RELATIVE LOAD CAPACITY FOR TYPES A AND B LOADING FOR EQUIVALENT MINIMUM FILM THICKNESSES

which is fixed in direction, one has the option of arranging the pads for type A or type B loading. If the selection is made on the basis of the greater load capacity, the best criterion for comparison is probably the minimum film thickness. Fig. 8 shows the relative load-carrying capacity of the two types of loading plotted against the equivalent minimum film-thickness variable $K_h(h_n/C)$, where K_h is a factor depending only on the pad proportions and is relatively constant for L/D from 0.15 to infinity.

It will be seen that on the basis of the same minimum film thickness, type B loading gives greater load-carrying capacity than type A loading.

EFFECT OF TYPE OF LOADING ON JOURNAL DISPLACEMENT

Since pivoted-pad bearings are used frequently to minimize journal displacement it is interesting to compare the relative eccentricity ratios for the two types of loading. The best way of doing this is on the basis of the bearing-characteristic number, $(R/C)^2\mu N/P$. This comparison has been made in Fig. 9 for bearings having 4, 6, 8, and 12 pads. It will be seen that the journal displacement for a given bearing-characteristic number is always less for bearing of type A loading.

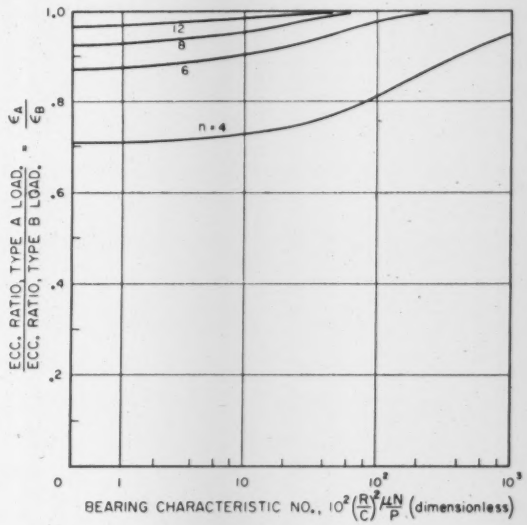


FIG. 9 RELATIVE ECCENTRICITY RATIOS FOR TYPES A AND B LOADING VERSUS BEARING-CHARACTERISTIC NUMBER, $L/D = 0.3$

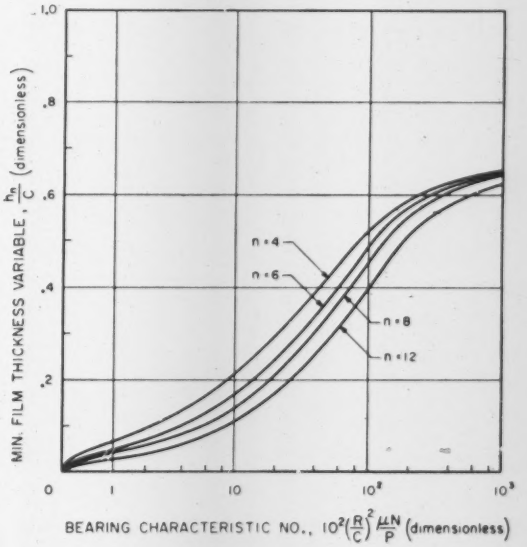


FIG. 10 EFFECT OF NUMBER OF PADS ON MINIMUM FILM-THICKNESS VARIABLE
($L/D = 1$, type A loading.)

EFFECT OF NUMBER OF PADS

If the L/D ratio of a bearing has been selected, it is desirable to know how a choice of the number of pads will affect the minimum film thickness and the load capacity. The relationship between these quantities for type A loading and $L/D = 1$ is shown in Fig. 10. The curves show that for a given load, that is, a given bearing-characteristic number, the minimum film thickness decreases as the number of pads increases. This can be explained by referring to Equation [3] which states that the load capacity of an individual pad depends on B^2L (as well as other quantities). If the diameter is fixed and the number of pads is increased, the load capacity on the individual pads decreases with the square of the number of pads, the net result being a decrease in the total load capacity of the bearing.

If both sides of Equation [7] are divided by L, the following relation between B/L and L/D is obtained

$$\frac{B}{L} = \frac{0.75\pi}{n(L/D)} \qquad [8]$$

It can be seen from this equation that where L/D is held constant while the number of pads is changed, as in the analysis of the preceding paragraph, the B/L ratio is correspondingly altered. Thus with $L/D = 1$, the B/L ratio for a 4-pad bearing is 0.59 and for a 12-pad bearing is 0.20.

When the L/D ratio is reduced to 0.3 to avoid the long narrow pad shape of the 12-pad bearing just considered, the curves for the two bearings are closer together as shown in Fig. 11, because the 4-pad bearing now has a less favorable pad proportion with regard to side flow.

COMPARISON WITH PLAIN JOURNAL BEARING

A comparison between a pivoted-pad bearing and a plain journal bearing[5] can best be made by again plotting against the bearing-characteristic number. This has been done for the minimum film-thickness variable for bearings of $L/D = 1$ and $L/D = 0.3$ in Figs. 12 and 13, respectively. The curves show that over a wide range of the characteristic number the minimum film thickness of the plain journal bearing is greater than that of the pivoted-pad bearing. The difference is less with $L/D = 0.3$ than with $L/D = 1$.

When compared with regard to eccentricity ratio, the pivoted-pad bearing shows less journal displacement than the plain journal bearing for all values of the characteristic number when both have $L/D = 0.3$, as is shown in Fig. 14. When $L/D = 1$, however, the curves cross as can be seen in Fig. 15.

Compared according to power loss as illustrated in Fig. 16, the journal bearing shows the greater power consumption

[5] The properties of the journal bearing used here for comparison were taken from the work of Cameron and Wood which takes into account film rupture in the "negative pressure" region: "The Full Journal Bearing," by A. Cameron and W. L. Wood, Proceedings of The Institution of Mechanical Engineers, vol. 161, WEP, 1949, pp. 59-72.

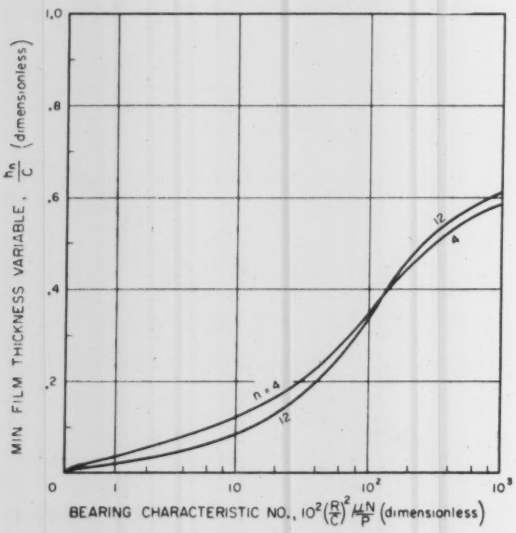


FIG. 11 EFFECT OF NUMBER OF PADS ON MINIMUM FILM-THICKNESS VARIABLE
($L/D = 0.3$, type A loading.)

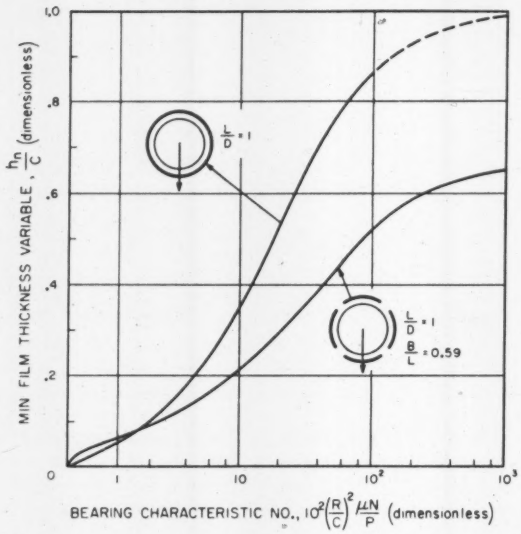

MIN FILM THICKNESS VARIABLE, $\frac{h_n}{C}$ (dimensionless)
BEARING CHARACTERISTIC NO., $10^2\left(\frac{R}{C}\right)^2\frac{\mu N}{P}$ (dimensionless)
$\frac{L}{D} = 1$
$\frac{L}{D} = 1$
$\frac{B}{L} = 0.59$

FIG. 12 COMPARISON OF MINIMUM FILM-THICKNESS VARIABLES FOR PIVOTED-PAD AND PLAIN JOURNAL BEARINGS HAVING $L/D = 1$

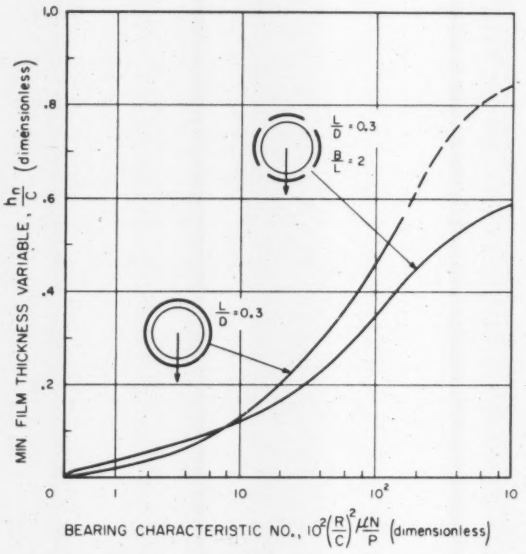

MIN FILM THICKNESS VARIABLE, $\frac{h_n}{C}$ (dimensionless)
BEARING CHARACTERISTIC NO., $10^2\left(\frac{R}{C}\right)^2\frac{\mu N}{P}$ (dimensionless)
$\frac{L}{D} = 0.3$
$\frac{B}{L} = 2$
$\frac{L}{D} = 0.3$

FIG. 13 COMPARISON OF MINIMUM FILM-THICKNESS VARIABLES FOR PIVOTED-PAD AND PLAIN JOURNAL BEARINGS HAVING $L/D = 0.3$

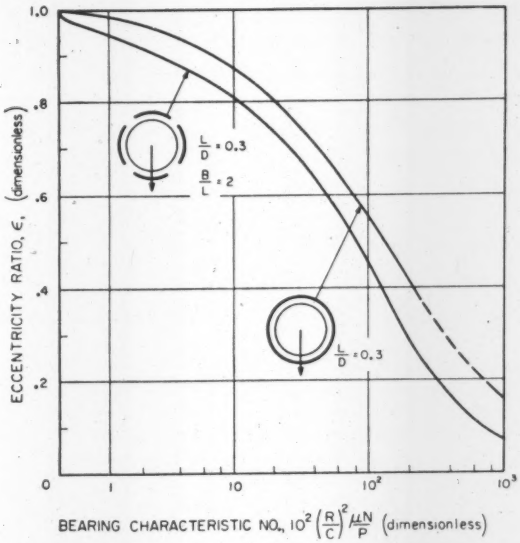


FIG. 14 COMPARISON OF ECCENTRICITY RATIOS FOR PIVOTED-PAD AND PLAIN JOURNAL BEARINGS HAVING $L/D = 0.3$

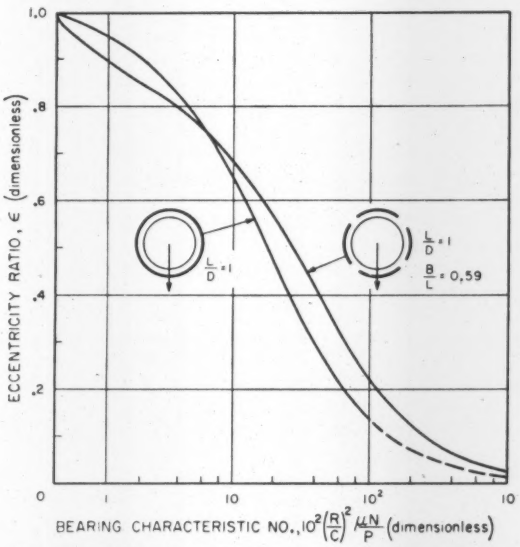


FIG. 15 COMPARISON OF ECCENTRICITY RATIOS FOR PIVOTED-PAD AND PLAIN JOURNAL BEARINGS HAVING $L/D = 1$

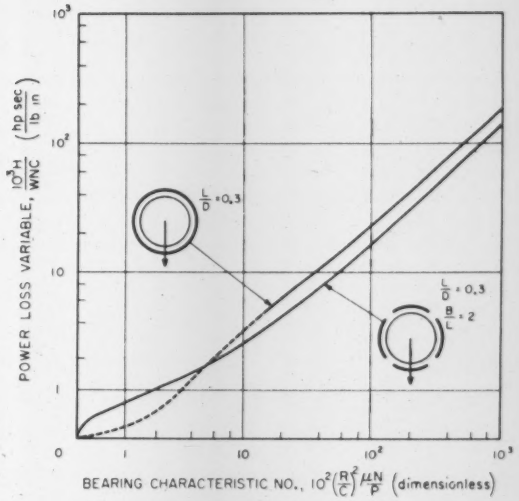

POWER LOSS VARIABLE, $\frac{10^3 H}{WNC}$ $\left(\frac{hp\ sec}{lb\ in}\right)$
BEARING CHARACTERISTIC NO., $10^2\left(\frac{R}{C}\right)^2\frac{\mu N}{P}$ (dimensionless)
$\frac{L}{D}$ = 0.3
$\frac{L}{D}$ = 0.3
$\frac{B}{L}$ = 2

FIG. 16 COMPARISON OF POWER LOSS VARIABLE FOR PIVOTED-PAD AND PLAIN JOURNAL BEARINGS HAVING $L/D = 0.3$

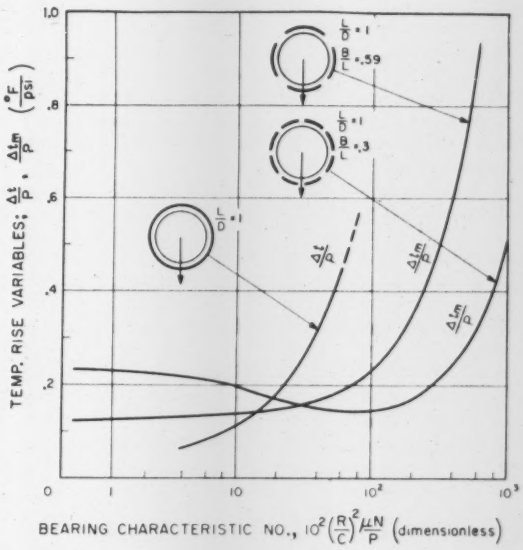


FIG. 17 COMPARISON OF TEMPERATURE-RISE VARIABLE FOR PIVOTED-PAD AND PLAIN JOURNAL BEARING HAVING $L/D = 1$

except for low values of the characteristic number. The dotted portion of the curve for the plain journal bearing, however, is open to some question since it was necessary to interpolate the data of Cameron and Wood in this region.

Fig. 17 is a comparison of the pivoted-pad and the plain journal bearing on the basis of film-temperature rise for an L/D ratio of 1. The film-temperature-rise variable for the plain journal bearing was calculated from the data of Cameron and Wood by assuming that all of the heat generated by friction went into increasing the temperature of the lubricant as it flowed once around the journal. Since the design of the housing and the lubricant passageways will influence the distribution and the amount of flow in a given pivoted-pad journal bearing, it is not practicable to postulate a general over-all temperature-rise variable for this type of bearing unless specific design details are known. A measure of the performance of a pivoted-pad bearing, however, can be gained from a consideration of the most heavily loaded pad. To facilitate comparison with a plain journal bearing, it is desirable to express the temperature-rise variable in terms of the total unit loading P rather than the unit load per pad P_i. This was done by use of Equation [6] with subscript i replaced by subscript m wherein P_m was substituted by the expression

$$P_m = \left(\frac{P_m}{P}\right)P = \left(\frac{2R}{B}\frac{W_m}{W}\right)P$$

Upon employing Equation [7] for B, the temperature rise variable for the maximum load pad is then obtained as

$$\frac{\Delta t_m}{P} = 1.33 \frac{n}{\pi} C_T \frac{W_m}{W} \quad [9]$$

and is a function of the bearing characteristic number since the ratio W_m/W is dependent on that quantity.

Fig. 17 shows the plain journal bearing to have a greater temperature rise than the maximum load pad of a tilting-pad journal bearing over a wide range of operation. This situtation reverses itself in the lower range of bearing characteristic numbers as can be seen by the crossing of the curves in that region. These differences are emphasized by increasing the number of pads from four to eight.

DISCUSSION

The analysis used here is based upon the assumption that the individual pads can be treated by plane-slider-bearing theory. This can be done correctly only if the radius of the pad is such that the film thickness between the pad and the journal is uniform when the pad is considered to be tipped, in imagination, until h_1 and h_2 are equal. To comply strictly with this requirement would necessitate that the radius of each pad should vary in such a manner that the center of curvature of the pad should at all times coincide with the journal center. As this is not the case for pads having a fixed curvature and since a precise treatment taking into account the exact film shape would be exceedingly tedious to carry out the analysis presented here is offered as an approximation to the practical case.

The conditions for rigorous accuracy are met quite well, however, in the case of a lightly loaded bearing if the pad radius is made equal to $R + C$. A similar condition exists for a heavily loaded bearing if the pad radius is made equal to the journal radius.

The great superiority of pivoted-pad journal bearings over plain journal bearings is a subject that has been strongly argued from time to time. The present treatment, however, shows that the plain journal bearing compares favorably with the pivoted-pad bearing and by many criteria is somewhat superior to the latter.

These statements should not be taken to mean that the pivoted-pad bearing does not have important advantages. High on the list of strong points is its ability to accommodate shaft angularity, although it also should be pointed out that a journal bearing arranged to pivot as a unit would have a similar advantage.

Another advantage of the pivoted-pad bearing is its freedom from oil-whip instability as has been shown by Hagg.[6]

An ideal application for such pivoted pads is on large-diameter, lightly loaded, vertical-axis guide bearings. Here the pads may be made comparatively small and the power loss reduced to a fraction of what it would be with a plain journal bearing.

Many pivoted-pad bearings are made with adjustable pivots beneath the pads. This permits a close control of clearance and permits operation with smaller clearances than those which would be considered proper for a plain journal bearing.

SUMMARY

The analysis shows the various performance characteristics for pivoted-pad journal bearing, compared for on-pivot (type A) and between-pivot (type B) loading.

No striking advantages over plain journal bearings can be shown on the basis of the properties determined in the analysis. Any real advantage over plain journal bearings is probably associated more with practical rather than theoretical considerations.

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance of Mr. R. W. Hagen and Mr. F. J. Kolano in carrying out many of the calculations involved in the preparation of this paper.

[6] "The Influence of Oil-Film Journal Bearings on the Stability of Rotating Machines," by A. C. Hagg, *Journal of Applied Mechanics*, Trans. ASME, vol. 68, 1946, p. A-211.

Management's Debt to the Engineer

(*Continued from page 379*)

custom and tradition. Or there is the temper of the modern medical man, who knows that his skill is based on a score of underlying sciences and can only develop by developments in those sciences and their application, who realizes that "clinical experience" does not mean his personal history but scores and hundreds of "cases" which provide an adequate statistical answer to some problem, who recognizes that in the interests of his patients he often must use imperfectly informed judgment, but tries his utmost to insure that when he does so his mind is controlled by the objectivity, the respect for facts and the care in amassing and assessing all available data which are the hallmarks of a true scientific training.

Practical management responsibilities can be met in one of those two tempers. You will find often that it is your duty, your inescapable duty, to make decisions where the facts are obscure and inadequate, the issues confused and the outcome highly speculative. The first syllable of management is man. Man is idiosyncratic, eccentric, often unreliable. In many directions we as yet know very little that is exact about his behavior and its causes. Go ahead we must. We can proceed "by guess or by God." Or, we can make the best use of the organized knowledge about the subject that is available, and, at the point where knowledge fails, fall back on a well-tested intellectual technique to eliminate the biases and the errors to which as human beings we are inevitably prone. Time after time you will feel that you are blind and groping, that science has failed you. It will not matter, unless your courage also fails you. The valor of ignorance is merely stupid; the courage that makes the best use of available knowledge and then consciously takes a calculated risk is one of the highest qualities of the human spirit.

Draw strength and comfort from the memory of the great men whose task is done, but whose story remains with us. Be valiant for Truth in your turn, a soldier of sincerity, and do not worry too much about the consequences. Keep untrammeled the breadth of vision, the generosity of outlook of your great profession which helped them, and which will help you and your sons and your sons' sons. Stick to the fifth stone of objective truth, and you will add a little piece in your turn to the great edifice we are all trying to build.

"Bless your blindness, glory in your groping,
Mock at your betters with an upward chin,
And when the moment has gone by for hoping,
Sling that fifth stone, O son of mine, and win.

Grief do I give you, grief and dreadful laughter,
Sackcloth for banner, ashes in your wine,
Go forth! Go forth! Nor ask me what comes after,
The fifth stone shall not fail you, son of mine.
Go forth! Go forth! And slay the Philistine!"[16]

[16] "The Young David," from "Twenty," by Stella Benson.

Mechanically Mounted CUTTING ELEMENTS *of* CEMENTED CARBIDE

By W. L. KENNICOTT

CHIEF ENGINEER, KENNAMETAL INCORPORATED, LATROBE, PA. MEMBER ASME

CUTTING-TOOL DESIGN FACTORS

CUTTING-tool design should be based on three principal factors: (1) The tool shape must be such that it will fit into the machine tool and perform the cutting operation involved. (2) The tool mechanism or construction should be based upon the physical and mechanical properties of the cutting element. (3) The composite assembly must be durable enough to stand operating conditions for an extended period of time, and be as simple as possible to maintain. The first and last of these requirements are generally recognized, but the properties of the cutting material are often ignored, and one type of cutting material substituted for another without changing the basic tool design.

PROPERTIES OF CUTTING-TOOL CARBIDES

Table 1 gives a list of the more important physical and mechanical properties of various types of cutting carbides, with properties of other common cutting materials and toolholder or shank materials, presented for comparison. It is evident from the table that cutting carbides have properties quite different from any other common engineering material, and, therefore, we may expect the most effective cutting-tool design to differ from designs for other cutting-tool materials.

Perhaps the most common problem involved in combining carbide and other common engineering materials into a composite part is the thermal-expansion rate. The thermal-expansion rate of carbide is one third to one half that of steel, and approximately one fourth that of commonly used brasses and bronzes. Fig. 1 illustrates the problem involved when a piece of carbide with low thermal-expansion rate is bonded by fusion of a brazing material, to a strip of steel with approximately twice or three times the rate of thermal expansion. At the solidification point of the brazing material, the two strips are unstrained and are straight and parallel. As the joined strips cool and contract, the steel contracts about twice as much as the carbide, causing the bimetal strip to bend as shown in the illustration. Of course, these are exaggerated sketches, as the carbide would pass its elastic limit and be broken before any such curvature could be accommodated.

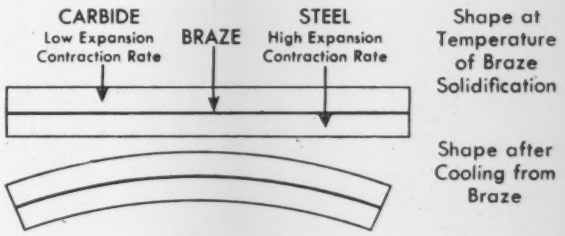


FIG. 1 ACTION OF CARBIDE BONDED TO STEEL

In the case of a cutting tool, the cutting edge is represented by the convex edge of the bimetal strip. This places the cutting edge in tension, making it extremely subject to failure as a result of concentrated pressures, changes in temperature from one portion of the cutting edge to the next, or minor notches

TABLE 1 PHYSICAL AND MECHANICAL PROPERTIES OF CUTTING CARBIDES

Material	Rockwell A hardness, 60 kg	Specific gravity, g per cc	Thermal expansion $\times 10^{-6}$/deg F up to 1200 F	Young's modulus of elasticity, psi	Transverse rupture strength, psi	Compressive strength, psi	Thermal conductivity, cal/deg C/cm/sec
A—Crater resistant steel cutting grades of cemented carbide	91.0 to 93.0	11.50 to 12.00	3.6 to 4.0	72,000,000 to 74,000,000	200,000 to 300,000	575,000 to 650,000	0.065 to 0.115
B—Edge-wear-resistant steel cutting grades of cemented carbide	91.0 to 92.5	12.50 to 13.50	3.7 to 3.9	79,000,000 to 81,000,000	225,000 to 275,000	650,000 to 725,000	0.120 to 0.140
C—Edge-wear-resistant grades of cemented carbide for cutting cast iron and nonferrous metals	90.00 to 93.00	14.00 to 15.10	2.5 to 3.1	77,000,000 to 94,000,000	200,000 to 325,000	675,000 to 850,000	0.140 to 0.190
Hardened high-speed steel, 18-4-1	85.0 max	8.6	7.0	32,500,000	.....	600,000	0.061
Cobalt-chrome tungsten cast alloys	83.5 to 85.5	8.30 to 8.80	8.0 to 9.4	30,000,000	160,000	.....	.....
1.10 per cent Carbon steel, heat-treated	83.0 max	7.80	8.2	29,500,000	.....	.....	0.140
60-40 Brass, cold-drawn	87 B-scale	8.40	11.6	15,000,000	.....	20,400	0.200

Contributed by the Research Committee on Cutting Fluids and Research Committee on Metal Cutting Data and Bibliography, and the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

such as would be produced by wear at the scale line of a cut. This residual stress in tension at the cutting edge may range from as little as 5 or 10 per cent of the ultimate strength of the carbide to well over 100 per cent of its strength.

Since curvature of the bonded parts is limited by the stiffness and size of the parts involved, strain must be absorbed or relieved within the assembly. Short lengths or small areas set up strains that are minor enough to be absorbed without weakening materially the parts involved, and a simple braze of well-proportioned parts, not excessively long or of large area, is commonly used for mounting of carbide inserts. On longer joints, the strain becomes proportionately greater and other

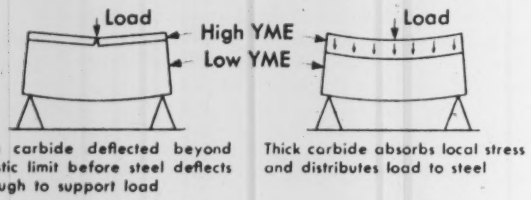

Load
High YME
Low YME
Load
Thin carbide deflected beyond elastic limit before steel deflects enough to support load
Thick carbide absorbs local stress and distributes load to steel

FIG. 2 EFFECT OF LOADING ON STEEL-BACKED CARBIDE

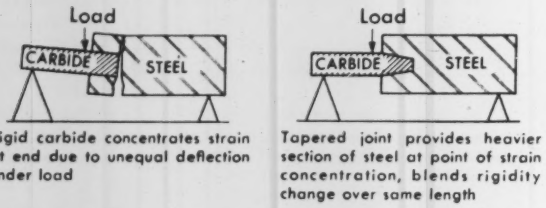

Load
CARBIDE
STEEL
Load
CARBIDE
STEEL
Rigid carbide concentrates strain at end due to unequal deflection under load
Tapered joint provides heavier section of steel at point of strain concentration, blends rigidity change over same length

FIG. 3 NOTCH EFFECT OF JOINT BETWEEN CARBIDE AND STEEL

methods of mounting are indicated. Many tricks are used to reduce the residual stress in a brazed assembly, such as a copper shim between bonding layers of silver solder, building up the cutting tool with a series of small carbide inserts, or even counterstraining the steel portion of the assembly after brazing to reduce or even reverse the residual stress in the bimetal assembly.

Mechanical mounting of the carbide plate or component eliminates the initial thermal condition since the assembly is made at room temperature, and temperature changes in operation usually can be accommodated by the mechanical mounting without setting up appreciable strain. Clamps, wedges, screws, or other holding devices may be used to hold the carbide mechanically on a body of steel or other material, and at the same time, permit the few ten thousandths of an inch movement necessary to relieve the stress due to temperature change.

Another physical property which brings up some problems in design is the high Young's modulus of elasticity of carbide. This is frequently an advantage in providing greater stiffness than can be obtained in other materials, but must be considered in designing composite parts such as cutting tools. Fig. 2 illustrates the comparatively poor backing which steel gives to carbide under load. The steel is able to deflect $2^1/_2$ to 3 times as far before reaching its elastic limit, and a thin piece of carbide frequently will have exceeded its elastic limit and fractured before the steel has deflected enough to take up its share of the load. When this condition occurs, the simplest solution is to use a carbide component of sufficient section, and particularly depth of section, to take up the localized loading, distribute that loading more evenly over the area of the joint between steel and carbide, and still stay within the elastic limit of the carbide. In other words, the carbide itself must act as a beam and be of sufficient cross section to support almost the entire load, the steel giving general rather than localized support. Under heavy localized load, the steel can be counted on to back up carbide only to about one third of the normal maximum beam strength of the steel.

Fig. 3 shows the notch effect of a joint between carbide and steel, due to the differential in Young's modulus. The greater stiffness of the carbide portion of the beam will concentrate the bending strain at its end unless the steel section of the assembly is increased considerably. The most common solution for such a problem is a tapered joint in which the steel section is strengthened materially at the end of the carbide, and the carbide section reduced over a definite length, distributing the bending stress and reducing the notch effect.

Mechanical strength in tension of the outermost fibers in a transverse rupture test, compression strength, and other common measurements of strength must be considered in tool design, but known values may be used in conventional calculations in most cases. One exception which must be kept in mind is that carbides have virtually no yield. This means that they are more sensitive to notch effect and concentrated stresses, and that a strained part will fail instantly when it reaches the elastic limit with no measurable permanent deformation before failure.

Thermal conductivity is an important property which is frequently overlooked. If a stiff material such as carbide is to be heated rapidly on one surface or edge, as in hot-forming, hot-spinning, and in some machining operations, it is important that the heat be conducted rapidly to all parts of the block or insert to permit uniform expansion. If only localized expansion takes place, surface checks, spalling, or thermal cracks will damage the tool. Incidentally, the low expansion rate is an advantage in this sense. Thermal conductivity varies with the type of carbide, some grades of tungsten carbide having nearly 3 times the thermal conductivity of others. Crater-resistant steel-cutting grades, having high percentages of titanium, tantalum, and columbium content, have the lowest conductivity.

Hardness is a measure of wear resistance in any type or group of carbides, and is usually the reason for using carbides. However, it does present some design problems in that setscrews and similar holding devices will not "bite" into the carbide and must be replaced by other holding methods or devices.

EFFECT OF PROPERTIES ON DESIGN

Now let us see how consideration of these various properties has affected the design, selection, and usage of carbide cutting tools.

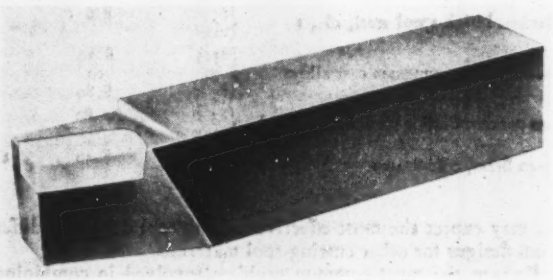


FIG. 4 TYPICAL BRAZED CONSTRUCTION CARBIDE CUTTING TOOL

Fig. 4 shows a typical single-point carbide tool with insert brazed in a recessed steel shank. The most popular shank sizes and cutting-edge contours are covered by standards of dimensions, tolerances, and catalog numbering in an American

Standards Association bulletin, sponsored by ASME. This type of tool is the lowest in first cost of the types presently available and should therefore be used for jobs of short duration which do not justify the expenditure for more-elaborate-type tools. The brazed construction also is frequently used in conjunction with other types of tooling, handling lighter operations such as chamfering.

These tools are satisfactory for light to medium cuts, but are inclined to develop thermal cracks in the carbide when subjected to heavy-duty operations, owing to the tight bonding of materials with different expansion rates. The steel shank is expendable so it is usually a high-carbon cold-drawn material with only moderate hardness and strength. Under heavy loads it may bend or mush, and it may be washed away by chip erosion. Position of the cutting point changes relative to the shank surfaces, as the tool is reground, and machine stops must be reset with each change of cutting edge.

While brazed tools of this type have done a creditable job, they are being replaced on heavy or long-run jobs by tools which get more out of the carbide through better basic design.

As contrasted with the brazed-type mounting of a cemented-carbide insert to a steel shank, various types of clamping mechanisms are in common use for holding a cutting insert in proper position in a holder or shank, permitting economies of operation not possible with the brazed-type tool.

CUTTING TOOL WITH MECHANICALLY CLAMPED INSERT

The simplest of these clamped tools is the one which mounts a solid insert in a recess roughly parallel to the bottom of the shank or holder, as illustrated in Fig. 5. The cutting insert is secured in place by a clamp, holding it down against the seat and back against solid supports on the side and back walls of the recess. Note that the holding mechanism clamps the cutting insert in the same direction as the cutting forces, and serves only to hold the insert in position until it is in the cut. Once in the cut, the tool will operate as well without any

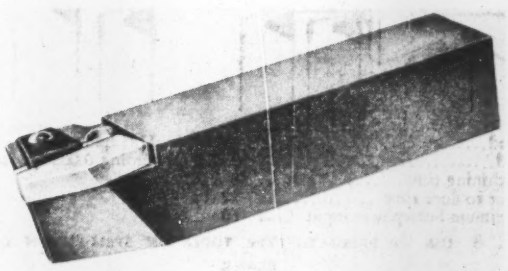
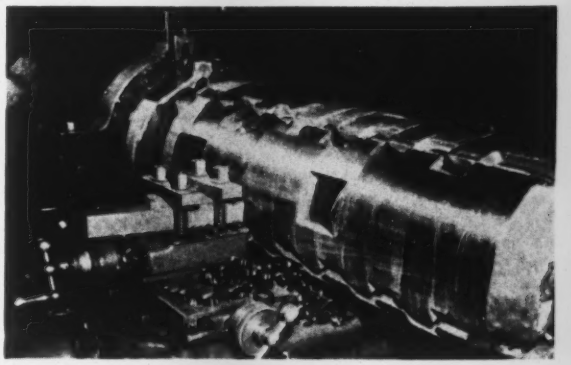


FIG. 5 CARBIDE CUTTING TOOL WITH MECHANICALLY CLAMPED INSERT

clamp, assuming a continuous machining operation. Taking a heavy cutting thrust on solid surfaces of hardened steel discourages chatter and reduces insert shifting and breakage.

Referring to our physical and mechanical properties, we find this type of tool should have many advantages over a large brazed-tip tool on equivalent work. Thermal-expansion rates will not cause trouble as the carbide insert can move relative to the steel seat. The section of insert is heavy enough to absorb localized loadings and distribute them over the support area so that the high modulus or stiffness becomes an advantage. No notch effect or localized stresses will be created in loading the insert or in cutting. As these heavy-duty tools usually run dry, they are subject to high temperatures along



Workpiece	Four-piece drum-segment assembly, 17 1/2 in. diam × 46 in. long
Material	Alloy-steel casting, 260 Bhn, with sand inclusions
Operation	Rough-turn in two cuts
Speed	30 rpm, 165 sfm
Feed	0.024 ipr
Depth of cut	1/2 in. per pass
Tool	K2S insert, H-type clamped design
Machining time	2 hr

FIG. 6 SEVERE INTERRUPTED CUTTING OF CAST STEEL

the cutting edge, and carbide grades of relatively high thermal conductivity are usually selected to prevent heat checks along the cutting edge.

Position of the cutting point is now maintained as the cutting inserts are reground or replaced. Naturally a minimum of stock removal and sharpening is desirable, sharpening only the cutting edges which are dulled and grinding only enough to recondition them. In average steel-machining, the ratio of wear is one part on the top surface, two parts on the side surface, and four parts on the end. Assuming a narrow negative land will be ground along the cutting edge at about 0 deg negative rake, the ratio of grinding stock on this tool is 0.7: 1.9 : 4 or very close to the ideal 1 : 2 : 4 ratio, and the "reserve" portion of the insert is not ground until it is needed.

The primary use for this type of tool is in heavy cutting operations, where a brazed tool is at a disadvantage owing to the possibility of thermal cracks and because of the comparatively soft steel seat under the tips of the brazed tool. With this clamp design it is possible to heat-treat the steel to the desired hardness or even to insert a shim of tool steel which will withstand operating temperatures to 1200 F and still provide a solid hard seat for the insert. The tool is somewhat easier to regrind because of being able to grind carbide only and retain the original form of the steel shank. It is also possible to replace the worn-out insert with a new one without replacing the entire tool. Initial cost is 2 or 3 times that of a brazed tool of equivalent shank size, so the performance of the tool of course must justify its use. The field of application is in boring mills, planers, and large lathes. Fig. 6 is an example of jobs done to advantage with such heavy-duty tools and the operating data show the performance possible with such a tool.

PRISMATIC-TYPE INSERTS

The second type of clamped tool has come into widespread usage during the past 4 years. It mounts a prism of solid cemented-carbide material on end, using a cross section of round, triangular, or square shape which provides multiple cutting edges on each of the two ends, Fig. 7. Therefore, a square insert of this type can be used 8 times before all the

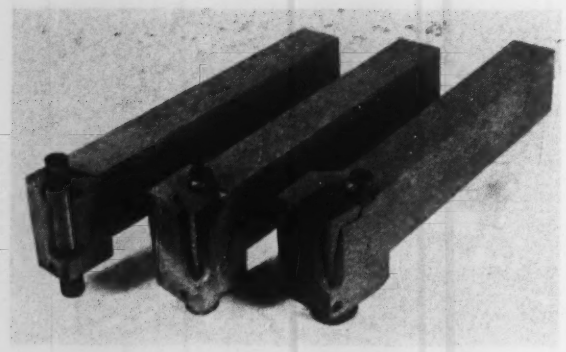


FIG. 7 HOLDERS AND INSERTS OF PRISMATIC TYPE

cutting edges are dulled and it requires reservicing in the toolroom. This design, like the previous one, eliminates thermal-expansion strains by permitting the slight movement necessary between the steel holder and the carbide cutting insert. Localized loadings are well distributed owing to the extremely deep section, and uniform section throughout the length prevents localized stress concentration. These tools usually are run with adequate coolant, but when operated at very high surface speeds, or with inadequate coolant, they sometimes require inserts of high-heat-conductivity grades to prevent heat-checking the cutting edge.

Ideal grinding-stock ratios are sacrificed in these tools, in favor of simplified grinding on the ends only, and consistency of cutting-point position so that little if any adjustment for workpiece size needs to be made when the insert is indexed or replaced, as it returns to almost the same identical setting in clamping. The round insert holder is used primarily for operations on cast iron. It has very effective cutting angles for this type of work and permits up to 14 indexes per grind according to the depth of cut being taken. Round inserts with diameters of $^3/_8$ and $^1/_2$ in. as well as the holders for them, are covered by American Standards through the ASME, and other rounds up to 2 in. diam are in common usage on large work. The large-diameter rounds generally are made in the form of a tube with a center hole of $^1/_2$ in. diam or larger to reduce the area for regrinding. The round also is used on some steel-finishing operations, particularly contouring in a tracer-type machine, as the large "nose radius" permits a smooth finish on shallow depths of cut with comparatively high feed rate.

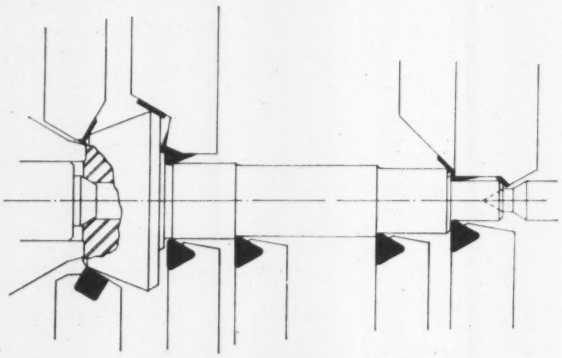
The square insert usually is mounted with a side-cutting-edge angle of about 15 deg which provides a similar end-cutting-edge angle and permits roughing cuts of moderate depths to be taken with high operating speeds and comparatively high feed rate. Square-section inserts of $^3/_8$, $^1/_2$, and $^3/_4$ in. and their holders are American Standards, and others up to $1^1/_4$ in. square are in common usage. The square-insert type is the most satisfactory for general steel turning or facing, as the insert has a strong 90-deg included angle at the point, coupled with the moderate size of nose radius desirable for efficient machining of steel.

The triangular insert is used for plunge-and-turn operations, cutting to a square shoulder, or tracer work where an included angle of less than 90 deg at the nose of the tool is desired. It is not as strong as the square insert, but because of its versatility, is the most common of the three sections. The triangular-insert tool has six cutting edges per grind of the insert, and is available in three industry standard sizes of $^1/_4$ in., $^3/_8$ in., and $^1/_2$ in., the dimension representing the diameter of an inscribed circle within the triangular cross section. The triangular insert also is useful on thin-wall tubing or small-diameter shafting where the sharper point creates less tool pressure and, consequently, less deflection of the workpiece during the machining cycle. Modifications of the square insert for deeper cuts are sometimes used, with inserts of rectangular or diamond-shaped cross sections.

A wide variety of clamping devices are used on these holders for prismatic inserts, ranging from the early holders with a saw cut placed longitudinally in the shank to permit closing around the insert, to some ingenious recent clamping development using a broached recess which accurately fits the prism of cemented carbide, and a clamping mechanism which forces the insert against the broached walls in the same direction as cutting pressure. These more recent developments supply better support for the insert, more durable toolholders from the standpoint of chip erosion, and more accurate indexing when the insert is rotated or replaced for a fresh cutting edge.

The prismatic-type clamped cutting tools are intended primarily for high-production or repetitive jobs, inasmuch as the economies of the tool depend upon longer life of a sharp cutting edge, less down time in changing cutting edges, reduced maintenance cost, since the insert needs only to be ground once every six to fourteen runs, and a very large number of potential sharp cutting edges in a new insert.

Fig. 8 illustrates the use of these tools in a multiple-tool semiautomatic machine, where extremely high surface speeds are used to complete the turning and facing operations on a stem



Speed	1200 rpm, 1185 fpm max
Feed	0.011 ipr turning 0.008 ipr facing
Machining time	8.5 sec
Floor to floor time	17 sec
Maximum horsepower input	66

FIG. 8 USE OF PRISMATIC-TYPE TOOLS ON STEM-PINION GEAR BLANK

pinion gear in a machining time of $8^1/_2$ sec per piece. This is, of course, on extremely high-production automotive parts, but serves to illustrate the speed of machining possible when conditions are ideal. In this case, a special-purpose machine tool was developed and built specifically for this job with provisions for rigidity and short-duration high power output never before thought necessary for such a small workpiece. Operations of this type would be impractical if each tool had to be adjusted for cutting position every time the cutting edge became dull, but owing to the accurate indexing, short down time, and simple operation of changing cutting edges, cutting-edge life in terms of pieces per grind can be sacrificed in favor of higher production.

INDEXABLE INSERTS

The previous two types of clamped cemented-carbide cutting tools are limited by the nature of their mechanism to

fairly large-size tools. Advantages of a clamped design are needed to a somewhat lesser degree on small tools, and a third type consists of a flat indexable insert mounted on a heat-treated steel shank with provisions for holding it against supporting shoulders in the direction of cutting thrust, Fig. 9. These indexable tips are designed for single use and discard without any regrinding whatever. The shapes of round, triangular, and square are selected according to the material being cut and the shoulder, contour, and so on, required.

Fig. 10 illustrates the application of the smaller indexable tip tools, the advantages of which are (1) the greatly reduced maintenance cost due to freedom from grinding; (2) the ability to operate at higher temperatures than an equivalent-size tool of brazed construction; (3) reduced down time as the tips may be indexed or replaced without removing the shanks from the holders or tool post.

The same indexable buttons in larger, thicker sizes are being applied to both old and new machines for "tracer" or "contour" machining operations on steel-mill rolls, dies, railroad wheel treads, contour-tracer work, and the like. The round heavy-duty button has another useful property, that of extreme durability. Having no point, it can take rough usage when backed up with a suitable holder, and has proved to be a natural for planer work, turning of heavy forged shafting, paper-mill rolls, and a railroad-wheel boring head for extremely rough work on high production.

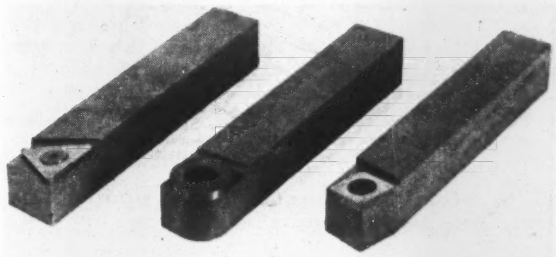
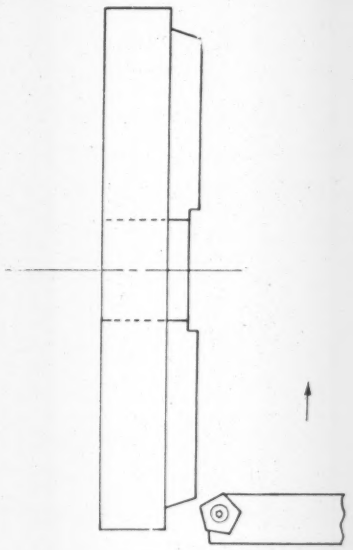
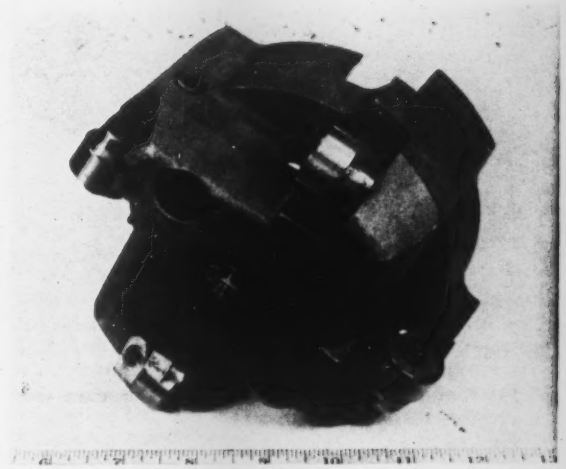


FIG. 9 HOLDERS AND INSERTS OF INDEXABLE BUTTON TYPE



Workpiece	Gear blank of 4620 forged steel
Operation	Face
Machine	Bullard "Multimatic"
Speed	200 sfm (max available)
Feed	0.015 ipr
Life	350 pieces per edge, 1750 pieces per insert, no regrinding

FIG. 10 INDEXABLE-INSERT TOOL FACING OVER INTERRUPTIONS



Workpiece	36-in-diam forged-steel car wheel
Machine	Snyder special boring mill, 75 hp
Operation	Rough bore 6-in-diam hole
Inserts	Four 1-in-diam × 1/2-in-thick, cylindrical shape K4H grade
Feed	0.044 ipr
Speed	320 sfm
Stock removal	1/2 in. per side, avg
Tool life	25 wheels per index (200 wheels per grind)

FIG. 11 STEP BORING BAR FOR ROUGHING RAILROAD-CAR WHEELS

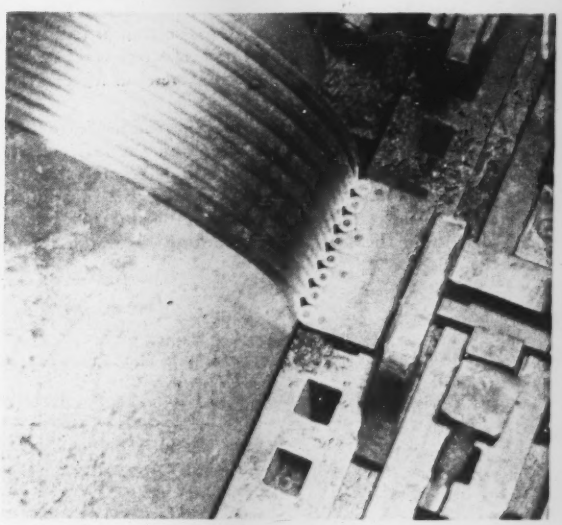


FIG. 12 ROUGHING CHILLED CAST-IRON ROLL, 75 SCLEROSCOPE HARDNESS, WITH K6 MULTIPLE-BUTTON TOOL

Fig. 11 illustrates the car-wheel boring head, which uses four of these durable rounds, positioned so as to divide the depth of cut between four of them and permits removal of heavy irregular stock.

Highly specialized tooling requirements have resulted in

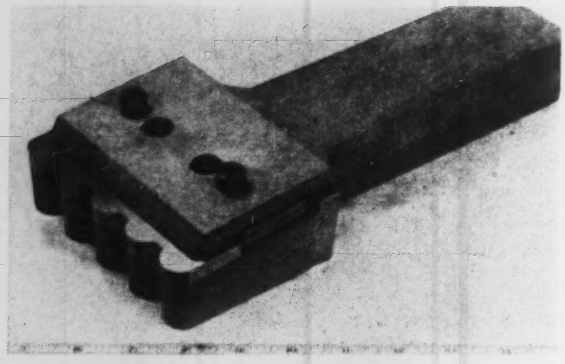


FIG. 13 FINISHING TOOL FOR FORMING PASSES ON HARD STEEL-MILL ROLLS

modifications of the foregoing basic types of clamped carbide tooling, plus some additional designs. Fig. 12, for example, illustrates the use of a tool mounting a series of cylindrical buttons for roughing down new or damaged chilled-iron steel-mill rolls, or for forming the passes in round section rod-mill rolls of hard steel. Fig. 13 shows a finishing blade for roll work, used with a straight edge for sheet and strip rolls, or with a contoured edge for rod-mill rolls.

Fig. 14 shows a tool mounting a triangular cross section insert at roughly horizontal position, providing a remarkably sturdy tool for the small included nose angle required in tracer or profiling lathes. The triangular cross section of the insert, nested into a mating V in the holder, provides resistance against side thrusts in either direction as well as vertical forces, right up to the extreme point of the tool.

All of these more or less specialty-application tools are based on the same design principles of avoiding thermal stresses, using the compressive strength and the high Young's modulus of the carbide to best advantage, avoiding localized loading or notch effect by selecting well-proportioned cutting elements which distribute the load quite uniformly over the seating surface of the holder, and providing for ease of maintenance.

Small tools of solid carbide for boring, have been common for many years. In the case of the piston-grooving tool in Fig. 15, however, the principal reason for using solid carbide is the high Young's modulus, or stiffness of the material. Comparing the same cutting grade of carbide, in a solid grooving tool and in a tipped steel-shank tool, shows over 3 times the life per grind because the solid blade has less tendency to wander in the cut and, therefore, shows less wear on the side surfaces of the blade.

CONCLUSION

The greatest advance in carbide tooling during recent years has been the recognition that any material has some physical and mechanical properties which are potential assets, and some which are potential liabilities. Only by careful consideration of these properties in designing, can we hope to get the best possible performance from the material. In the case of hard carbide cutting tools, remarkable improvement in performance and broadening of the field of application has resulted from improved tool design based upon laboratory-determined properties.

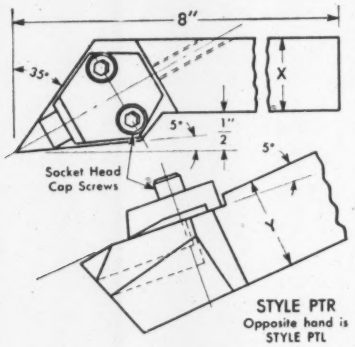
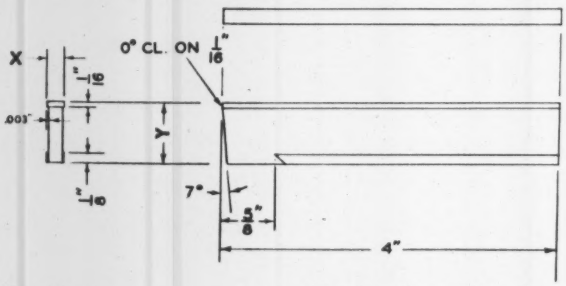


FIG. 14 SPECIAL DESIGN CUTTING TOOL FOR PROFILING LATHE WORK, MOUNTING TRIANGULAR SECTION INSERT IN V-SEAT



Material	Cast-iron piston, 2⅝ in. diam
Operation	Groove for piston rings
Machine	Acme Gridley

Performance

Tool	Brazed tip	Solid carbide
Feed, in.	0.022	0.022
Rpm	340	340
Sfm	233	233
Machining time, min	0.25	0.25
Production per hour	219	219
Pieces per grind (avg)	900	2900
No. of regrinds	25	135
No. of pieces per set of 4 tools	22500	391500
Tool cost each, dollars	6.25	14.50
Tool cost per piece, cents	0.11	0.015

FIG. 15 SOLID-CARBIDE PISTON-GROOVING TOOL

ENGINEERING *in* *Small* MANUFACTURING PLANTS

By DEAN B. CHENOWETH[1]

CHIEF ENGINEER AND ASSISTANT TO PLANT MANAGER, FOLEY MANUFACTURING COMPANY, MINNEAPOLIS, MINN. MEMBER ASME

WE'VE become accustomed to hearing of the "science of economics." I think of engineering as the "economics of science."

Economics dictates the progress of any company. However, the small company often has less of the wealth of company history to guide its evolution, less likelihood of monopolistic advantage, relatively limited product lines, and is faced with a higher measure of dependence upon the fortunes of the market.

Engineers in such organizations must cover the range of activities usually found in larger firms, but their numbers probably are limited to such an extent that indulgence in a high order of specialty is prohibited. Each man generally steers his own project through preliminary specification, product design and development, methods and tool design, cost estimating, gage design and inspection standards, preparation of operating manuals, procurement of underwriters' approval, and patent search and application procedures.

Then comes the production follow-up; on-the-spot approval of necessary design modifications, refereeing of production-inspection differences, and interpretation of field results, to mention a few areas of the problem.

The small company usually operates on a budget trimmed nearer the essentials, sometimes below them as viewed by the engineer with a special project in mind. In blending the findings of science to produce a solution to a material problem he must give proper consideration to the pressures acting on the system, pressures taking the form of cost and availability of material, the supply of manpower, including supervision, which may be at his disposal, estimated volumes in the various product lines, capacity of plant and equipment, and current management policy regarding capital expansion to cite a few. These pressures will define the boundaries and scope of the engineering program which he undertakes.

An additional problem for the engineer is superimposed on these today in the matter of government controls on materials and the ever-present possibility of forced substitutions. He must learn to compromise with facility as such emergencies arise. Naturally, the smaller the business unit, the faster is its reaction to these forces.

DEVELOPING AN ENGINEERING PROGRAM

In the typical competitive manufacturing situation, development of an engineering program and the growth of the company are complementary; their relationship is much like the proverbial "chicken and the egg."

This condition generates inherent problems for the engineer in a small company in such forms as limitations on staff and equipment, short deadlines for release of information, and less than adequate periods of incubation for new ideas. In early stages of the program he must develop engineering standards and procedures along with directing current projects.

These factors place on him the responsibility for ranging over a crowded agenda to select problems of greatest urgency and to direct management's attention to salient facts on these matters. Such a responsibility only begins with identification of a problem, however. Presentation of the problem is a worthless effort unless followed by a recommendation for action. The engineer must submit a well-planned solution, one that will stand the economist's test.

In conveying what he considers a good solution a common error the engineer makes is to overemphasize technical perfection. Good engineering thinking results from a proper sense of proportion. We might profit by an examination of the economist's concept of "marginal utility." To paraphrase this idea crudely, when resources are limited, apply them in the avenue of maximum gain. Maximum gain means maximum satisfaction for all parties who are relying on the engineer's decisions. An example of the other avenue of application came to mind recently when my wife slyly reported, "I got the stains out of the linen table cloth. Now all I have to do is sew up the holes."

Many small organizations are started by persons whose interests lie primarily along nontechnical lines. In such companies an engineering program, arriving later on the scene, is due for its share of growing pains; however, these usually are not so severe that conscientious effort cannot reduce them. Placed in a pioneering position such as this, the engineer should make it his primary objective to foster mutual understanding and confidence between his group and the management. By continuous application of sound economics, he must demonstrate the potential value of an adequate engineering program.

INCENTIVES IN SMALL COMPANIES

The small company interested in establishing an engineering program cannot always offer a candidate a time-tested security. It must require that he be willing to gamble a little on the growth potential of the company. The new man usually is not invited to participate in an extensive job-training program, but must start swimming immediately. This fact is not mentioned as an advantage of small firms over large, rather it represents one of the serious deterrents in technical manpower procurement for such organizations.

Favoring the small company there do exist offsetting incentives for the applicant, among them closer association with top management, less organizational inertia, more freedom of decision, and generally a wider variety of problems in the daily schedule.

Many excellent opportunities exist today in companies of 500 employees or less, but, owing to the absence of an active public-relations plan related to manpower procurement, many of these companies are not attracting their fair share of applicants. In such instances the underlying problem is probably management's lack of familiarity with the objectives of an engineering program. Such companies undergo costly adjustments in

[1] Chairman of the Minnesota Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Presented at a meeting of the Minnesota Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, February 4, 1953.

attitude upon discovering that sound engineering plans demand the preventive rather than merely the corrective outlook in meeting competitive problems.

The engineer in this environment struggles to keep the program on the offensive rather than on the defensive. His fundamental concern is that of converting his group from an emergency squad to a source of reliable information for long-range planning.

The basic challenge for the engineer is to have his decisions and recommendations stand up under trial. Obtaining management approval of critical engineering decisions sometimes must precede the trial, and such approval is difficult to obtain without a definite plan of presentation.

A PRACTICAL APPROACH

"Stop now," if you would not pursue the recommended course in spending your own money. It should be axiomatic that what's good for the individual must first be good for the company. You must prove to your management that you will solve a definite problem for them and not merely make something easier for an isolated group.

The boss is a busy man and much more interested in answers than in questions, invariably more sympathetic toward results than toward plans, and generally a very poor loser where his pocketbook is concerned. These things are as they should be, and the individual man in engineering work does well to bear these factors in mind for application to his daily routine of making decisions. In so doing his percentage of good decisions will be higher.

The typical engineer is like a driver on ice, anxious to go some place but cautious not to push the project so fast that he cannot change direction in an emergency. He's largely responsible for his own dilemma, however, in not having sold his lay associates on the fact that engineering results are not as exact nor entirely predictable as the popular notions would indicate. There is much room for personal opinion. The breach between question and answer narrows with increased knowledge of the facts but may never be closed entirely, and it is therefore possible to qualify a statement without sacrificing authority. Honest reservation fosters confidence, and a good executive shudders at the habitual "fast answer" man; he learned long ago that no one knows everything.

Do not hesitate to assume the offensive when you know your facts. The man is paying you for your advice even though, for reasons of his own, he may choose not to follow it. His choice does not relieve you of the responsibility for having an opinion and for making it known. But on this point a word of caution is due—practice the art of distinguishing between a request for advice and a request for information. These terms are not synonymous, and many a snag lies in the course when they become confused.

Experience comes through active contribution, not by passive observation. The measure of a man's experience is the degree of correlation existing between his opinions and the facts. In devoting 30 or 40 years of our lives to engineering problems we should make it our earnest objective to realize that many years of experience in the larger dimension of the term and not merely 40 years of association with the issues. Problems are not the load one carries, they're the fuel that keeps one advancing.

CONCLUSION

Small plants have hardly begun to utilize engineering services effectively. There is a bright future for the "general practitioner" in engineering provided he's well-rounded in fundamentals and sufficiently aware of his own limitations to consult a specialist at the proper time. He need not sense an inferiority at this experience but should welcome a chance to work with the expert, thereby sharpening his understanding and interest in a new field. As the resident engineer he still makes the final decision.

The progress of any organization, large or small, is built more on abilities and aptitudes of the staff than on a functional formula. Reliance must be placed not on channels of authority but rather on the judgment of individuals to produce results.

FIRST PRODUCTION MODEL OF NEWEST AND MOST POWERFUL HIGH-SPEED ELECTRONIC CALCULATOR, THE "701" INTRODUCED RECENTLY BY INTERNATIONAL BUSINESS MACHINES CORPORATION, NEW YORK, N. Y.

(Composed of 11 compact and connected units, the new calculator uses all three of the most advanced electronic storage or memory devices—cathode-ray tubes, magnetic drums, and magnetic tapes. It can multiply and divide more than 2000 times a second and can add and subtract more than 16,000 times a second. While solving a typical problem, the 701 is capable of performing 14,000 mathematical operations a second. In the center of the units, above, is the Electronic Analytical Control Unit, and at its right is a Card Reader. Behind the control unit is the Power Distribution Unit. On the left are the Magnetic Drum Storage Unit and the Electrostatic Storage Unit. In the group at the right are two Magnetic Tape Readers and Recorders, the Alphabetical and Numerical Printer, and the Card Punch.)

EUSEC CONFERENCE ON ENGINEERING EDUCATION

THE conference of representatives from the Engineering Societies of the United States and Western Europe (EUSEC) was held in London, England, Jan. 12–17, 1953. European countries represented were Norway, Sweden, Denmark, Western Germany, Holland, Belgium, France, Switzerland, Italy, and the United Kingdom. Finland was not represented but a memorandum was received from that country. The United States delegation, which was sponsored by the Engineers' Council for Professional Development, was made up of Dean Thorndike Saville of New York University, chairman of the ECPD Education Committee; Dean W. R. Woolrich of the University of Texas and president of The American Society for Engineering Education; and Dr. L. F. Grant, chairman of Engineers' Council for Professional Development.

The conference was for the exchange of ideas and no attempt was made to reach conclusions. The discussions were extremely valuable in clarifying the different systems and in developing a mutual understanding of the principal methods of engineering education in the several countries.

The procedure adopted was for a representative of each country concerned to send in advance a description of the method of education and training of professional engineers in his country to the Honorary Secretary of the conference, E. Graham Clark, who is also Secretary of The Institution of Civil Engineers of Great Britain. These were then translated into English, if necessary, printed, and circulated well in advance to all the delegates. The American report was written by Dean Saville, and because of the previously expressed interest by some of the European societies in American engineering education, was rather longer than most of the others.

All meetings, or working sessions, were held either at the headquarters of The Institution of Civil Engineers in Great George Street, The Institution of Mechanical Engineers in Storey's Gate, St. James Park, or The Institution of Electrical Engineers in Savoy Place, and various officers of the three Institutions acted as chairmen.

At the first session an opportunity was given to a delegate from each country, in alphabetical order, to comment on the report from his own country, following which there was a period in which the previous speakers were questioned by delegates from the other countries. These two periods lasted through both sessions of January 12.

From the outset a difficulty arose from the different meanings attached to certain expressions in common use. Such terms as "professional engineers," "practical training," "basic science," to mention only three, caused some misapprehension, but as the conference progressed the delegates rapidly learned to comprehend each other.

The third session was given over to "Standards and Criteria of Entry" which opened with full and detailed description of the system in the United Kingdom which in turn led to a period of general questioning and discussion during which a fairly clear picture of the situation in all of the countries was presented. Some of the standards for entry to formal engineering education seemed rather surprising to those accustomed to the American procedure. For instance, in Britain the standard of entry into a university is a year higher than that generally required here, but on the other hand, the university course lasts for only three years, so that the end result is probably not much different.

In the course of this discussion a great deal of interest was aroused by the statement of one of the Swiss representatives, that students who had taken a classical course in the schools did better on an average in the University than those who had taken a mathematical type of course. One of the British delegates commented on this by saying that the experience in Britain was much the same but explained it by saying that the headmaster of a school had told him: "We make every effort to put the best boys in the classical course of our schools, and then we claim that the classics produce the best boys."

This discussion also brought about the fact that in some of the European countries—notably Holland and Switzerland—a university is obliged to accept any student who qualifies, as do some publicly supported colleges in the United States. This, however, is not the case in Britain.

THE PLACE OF BASIC SCIENCE AND TECHNOLOGICAL STUDIES IN THE EDUCATION OF THE ENGINEER

On this subject the United Kingdom delegates emphasized their view that an undergraduate course in engineering cannot produce an engineer. While all of the delegates agreed with the general philosophy, there was a somewhat wide divergence of opinion as to the significance and interpretation of "practical training." The delegates were in general agreement that the undergraduate course in engineering merely produces someone who has a broad understanding of engineering principles, and they expect the advanced technological aspects of engineering to be in a postgraduate course or else be acquired during the period of employment following graduation when a man is undergoing his practical training. In general, the delegates agreed that it was not possible to produce a competent design engineer by university work alone. Several representatives suggested that unless a good deal of engineering (technological) work is given at the university, students become rather bored with studying broad principles only. In some cases it was even said that engineering was being taught by professors of mathematics and physics, a remark which led some of the delegates to say: "What is sauce for the goose, should be sauce for the gander," and that it might be advantageous if mechanical and pure science subjects were taught by engineers.

THE PLACE OF GENERAL STUDIES WITH SPECIAL REFERENCE TO THE HUMANITIES IN THE EDUCATION OF THE ENGINEER

For the purpose of this session the chairman suggested that such subjects should be considered as labor management, human relations, social science, economics, administration, law, legislation, aesthetics, philosophy, commerce, organization, and finance. As the discussion continued, literature, music, art, and architecture were also talked about and readers of this report will not be surprised to learn that the differences here were very great. One interesting experiment mentioned, which apparently has been very successful, is on one afternoon a week to postpone all afternoon periods one hour, thus allowing a free hour after lunch, during which a lecture on one of these subjects is given. Attendance, although voluntary, is more than can be accommodated.

The French delegates agreed emphatically with the American

Prepared by L. F. Grant, chairman, Engineers' Council for Professional Development.

point of view that there is little value in lectures on such subjects unless there is an examination. The Italians, on the other hand, thought that such subjects were out of place in an engineering course, and that what is more important are technical subjects. As their spokesman said, "We think that a course on electrical machinery and hydraulics, for instance, can be given in a humanistic rather than an exaggeratedly technical manner." Possibly the Italians take this view because of the artistic background which they already have. The Scandinavians deprecated formal courses but do have a number of lectures on cultural and other subjects arranged by the students. Holland seemed to occupy an intermediate position between the United States and Switzerland, on one side, and the Scandinavian countries on the other.

THE PRACTICAL TRAINING NECESSARY FOR QUALIFICATION AS A PROFESSIONAL ENGINEER

The practical training here discussed did not deal with practical work within universities, such as surveying, drafting, and so on, but with training in industry. For instance, the British require two years of training under a member of one of the Institutions, plus one year of general experience, before a man can apply for admission to one of the Institutions. It should here be noted that there is in none of the other countries a legal system of examining and licensing engineers such as is carried on in the various States of the United States and the Provinces of Canada. In Britain, membership in one of the three Institutions in effect confers the right to professional standing. In some of the continental countries graduation from one of the engineering colleges confers the legal right to practice.

In Belguim and Sweden, practical training is done before the student enters the university. In Holland and Canada it is carried out during vacations and the student is required to submit at the beginning of his second, third, and fourth year a report on the work he has done in the preceding summer. In general, it may be said that the British place a higher value on practical work (often of a subprofessional character) than do the other countries. The situation as regards training schemes by industries is as varied in Europe as on this continent. It seems that many of the bigger industries give formal courses to young engineers, but not many of the smaller ones. In Switzerland where there is no legal protection for the title of engineer, no practical work is required.

THE FULL REQUIREMENTS FOR CONFERMENT OF PROFESSIONAL STATUS

This topic, of course, led to a discussion of the definition of a professional engineer, but the one quoted below seemed to find general acceptance:

> A professional engineer is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the solution of problems and to assume personal responsibility for the development and application of engineering science and techniques especially in research, designing, manufacturing, superintending, and managing.

Professional status in the United States and Canada is achieved by a variety of means, but these countries are unique in the legal recognition of professional practice through examination and registration. In Sweden, Switzerland, Belgium, Norway, France, Holland, and Germany, there is required a diploma from a college recognized by the government, and in the United Kingdom professional status depends on corporate membership in a professional institution. Denmark falls under all three headings. All countries seem to provide written examinations for those engineers who have not graduated from a recognized university and who through practical experience and private study have fitted themselves for professional status.

A briefer description of accreditation as carried out in the United States by ECPD was given by Dean Saville at the end of this session.

OTHER ACTIVITIES OF THE CONFERENCE

The final session was devoted to the consideration of plans for the future and it was the unanimous wish that EUSEC should be asked to authorize another conference in another country in 1954, and that in the interim a committee be asked to prepare a glossary of terms in common use so that they would have the same meaning for all the delegates.

Besides the working sessions described above, the delegates visited the Imperial College of Science in London, Brighton Technical College, Rugby Technical College, and Cambridge University. The system at Cambridge is, perhaps, closer to the North American practice than at the other institutions visited. The delegates were also shown training methods for both technicians and engineers in the British Thomson-Houston works, and the English Electric Company at Rugby.

The hospitality of our British hosts was unlimited; luncheon, tea, dinner (and other refreshment of a less academic nature) were provided as well as special railway carriages for the visits to Brighton, Rugby, and Cambridge. The delegates were also entertained at dinner by Viscount Falmouth, Chairman of the Board of Directors of the Imperial College, and by the Mayor and Corporation of Brighton, and at luncheon by the Master of Emmanual College, Cambridge.

Millipore Filters

A NEW filtering medium with pores separated by walls not much thicker than molecules is now offered for bacteriological research and other special jobs, according to the *Industrial Bulletin* of Arthur D. Little, Inc., Cambridge, Mass. Finished millipore filters look like fairly thin sheets of paper, and are actually made up of cellulose-based chemicals. However, the *Bulletin* states, there the similarity ends. The filters are said to contain approximately 80 per cent voids, arranged in a uniform cell structure of about 50 million pores per sq cm of cross section. The filter passages, much smaller and much more uniform than in the finest filter papers, are capable of acting as definitive separatory screens for particles smaller than one millionth of an inch in diam.

Possibly the most interesting application of the millipore filter, in the eyes of the bacteriologist, is its use as a porous mixture on which to grow micro-organisms for study. Bacteria retained on the very surface of the capillary structure may be kept well and evenly fed, and their growth carefully controlled, with only a few drops of culture medium (food supply). Thus, the new filters may cut costs of routine tests and increase accuracy at much greater convenience than with standard agar and petri-dish techniques.

Outside the bacteriological field, the millipore filters have been used for experiments in dust sampling, filtration of airborne radioactive dust, and selective filtration of ultrafine dispersions, among other things. Commercial applications are as yet undetermined, the article states, but the membranes themselves have been made in sizes up to 2 ft × 4 ft, with good reproducibility, and can thus be used in some chemical filtrations up to pilot-plant scale. The manufacturers, Lovell Chemical Company of Watertown, Mass., feel that as the right techniques of use are developed, their research tool of today will become another production aid for tomorrow.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Technical Editor*

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Russian Engineering Training

DETAILS of an intensive training program to develop production experts for the USSR, now in progress in Soviet Russia, which may constitute a serious threat to U. S. economic and military superiority, are revealed in the February, 1953, issue of *Product Engineering*.

If this engineering training program, which has produced some brilliant Soviet engineers, succeeds in developing production experts as good, the U. S. may find Russia forging ahead as a world power.

Recognizing that their country's major deficiency was a lack of industrialization and its biggest headache the need for technical personnel, the Soviets have increased the few universities inherited from the Tzarist regime to 890 institutions with an enrollment of 1,400,000.

Special incentives for successful completion of the courses are set up by the Russians, including bonuses and higher pay scales, more food and clothing rations, community prestige, military deferment, and the like. On the other hand, the student who fails to make the grade may end up anywhere in the controlled economy.

The program encompasses two types of colleges: Polytechnical institutes for the study of various engineering fields and sciences, and specialized institutes where students concentrate on critically needed subjects like railroad engineering, machine design, or mining.

Basically, Russian engineering curricula compare with cooperative programs at a few American universities, the article points out. They combine actual work experience with classroom theory. The Russian student studies the same subjects as the American, but he spends 800 more hours in the classroom. Also, his studies put more emphasis on creative design.

According to *Product Engineering*, the usual Russian engineering curriculum spans five years. The first three, the same at all colleges, are devoted to basic fundamentals of engineering with heavy doses of political and social sciences. Academic subjects add up to about 5000 hours, 2700 of which are devoted to general engineering subjects. In the last two senior years students spend 1500 hours on specialized subjects. This leaves politically conscious Reds almost 800 hours for the study of humanity subjects.

Equally as important as classroom subjects in the Russian course are three other phases: So-called instructional projects, scientific research, and work practice. The instructional projects can be compared to American term papers except that they are usually more specific, more detailed, and practical. Three of these are required and each includes five or six blueprints as well as a complete description of the subject. One must be on machine parts, one on hoisting machines and mechanisms, and one on theory of machines and mechanisms.

During specialized training the student also completes two or three additional projects in his own field and for these he must take part in scientific research. The state sets up circles of research at the various colleges and professors direct undergraduates in this work in the same manner that American faculties direct graduate students, the article explains.

Work practice periods, in which the student is assigned to an actual industrial operation, break up the routine of the fourth and fifth years. Students travel to their work assignments with an instructor who assumes responsibility for them. The state pays all expenses.

In his first work period the student handles two or three low-echelon jobs learning a limited amount about industrial operation, but in his last period he serves as assistant to the heads of various departments. The plant arranges seminars for students to give them specific details about the plant's operation along with an over-all picture of the industry.

Like the American student in co-operative training, the Russian student prepares reports on his work period, but unlike the American, he also must prepare a critical technical analysis of the work and methods of the plant with recommendations for improvement. These are forwarded to the industries involved so that they can adopt sound student recommendations.

Final test before graduation is the design and defense of a graduation project, usually design of a complex engineering product in the student's specialized field. A typical one requires 10 to 15 blueprints and 100 to 120 pages of calculation and may call for independent research. The student must then defend his approach, use of materials, and general design before the Board of Examiners.

When he passes, this board appoints him to an engineering

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

position at a factory, plant, mine, building job, or railroad. Those who have shown a bent for scientific research are permitted to take a postgraduate course.

This intensive training program will come as a surprise to many American engineers who have underestimated the Russian engineers. However, the Russians are well known for their leadership in certain fields, particularly aerodynamics. Many engineering leaders in American aircraft plants have been of Russian origin and received their academic training in Russia.

Pilotless Aircraft

INFORMATION on one of the nation's newest pilotless target drone aircraft, the Ryan Q-2 "Firebee," was released recently by the U. S. Air Force's Air Research and Development Command, Baltimore, Md., as the first announced development of its kind to emerge from the nation's huge guided-missiles program. The drone is somewhat less than half the size of present-day jet fighters and has performance characteristics that simulate jet aircraft now in combat in Korea.

In the high-speed class, the Firebee, which can operate at high altitudes, is powered by a Fairchild J-44 turbojet engine of about 950 lb thrust. The engine is approximately 6 ft long, 22 in. in diam. The mid-wing all-metal robot has sharply swept-back wings and tail surfaces. It has an approximate 12-ft span and 18-ft length. It weighs about 1800 lb.

The near-sonic speed, recoverable drone has been under test for the past two years at the Air Research and Development Command's Holloman Air Development Center, Alamogordo, N. Mex. The Firebee is a joint project of the Air Force, Army, and Navy, with the Air Force's Air Research and Development Command having the responsibility for technical aspects of its development. Engineers of this Command's Wright Air Development Center, Dayton, Ohio, assisted the Ryan Aeronautical Company, San Diego, Calif., in developing the drone.

The principal mission of the Firebee which has been revealed is its use as a drone target for modern defense weapons. It is designed to offer a high-speed target capable of simulating piloted jet-plane maneuvers for the training of antiaircraft crews. It is equally adaptable for ground-to-air tracking and firing and for air-to-air interception problems.

The Firebee is operated from a "black box" remote-control station where a small control stick, and switches needed to change engine speed and other flight conditions, transmit command signals to the "nolo" (no live operator) aircraft. It can be flown out-of-sight and at high altitudes.

In order to achieve the most economical employment of the Q-2 through its repeated use as a drone, Ryan Aeronautical Company and Air Force technicians from the Wright Air Development Center developed a two-stage parachute system to decelerate the drone from its near-sonic operating speed and lower it safely to the ground without damage to the aircraft structure or the delicate electronic controls.

The recovery system is capable of lowering the drone to the ground automatically in the event of drone hit, loss of radio wave carrier from the remote-control station, engine failure, or upon command by the remote-control operator. There has been a high percentage of completely successful recoveries of actual drones during flight. In order to prevent damage to the target by ground winds dragging the Firebee after recovery, the parachute system incorporates a ground disconnect system which causes the chute to become detached from the drone upon contact with the ground.

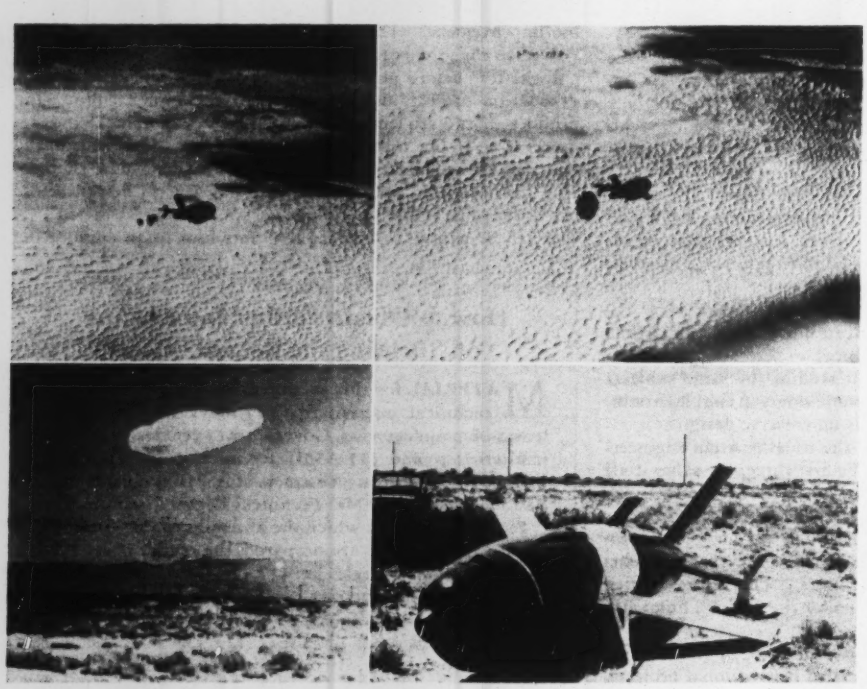


FIG. 1 TYPICAL RECOVERY OF A RYAN "FIREBEE" PILOTLESS TARGET DRONE PLANE DURING A U. S. AIR FORCE DEVELOPMENT TEST AT THE HOLLOMAN AIR DEVELOPMENT CENTER, ALAMOGORDO, N. MEX.

(The Ryan Firebee uses a two-stage system parachute that will open at speeds up to 600 mph and bring the drone plane down so carefully its electronic system is not damaged. When the Q-2 touches the ground the parachute detaches itself to prevent ground winds from wrecking the jet target plane.)

In the test program at the Holloman Air Development Center, the Firebee has been launched on numerous flights both from the belly and wings of twin-engine "mother" aircraft. It has also been successfully launched from the ground.

While most of the flights of the drone have been made with the Fairchild J-44 engine, the drone has also been tested with the J-69 Marbore 11 jet engine, developed in France by Turbomeca and scheduled to be manufactured in this country by Continental.

The Ryan drone is composed of five major assemblies: Fuselage, nacelle, wing, empennage, and parachute container. Construction is of aluminum, magnesium, and stainless steel.

For ease of assembly and maintenance in the field, the Firebee design incorporates many novel features. The wings attach to the fuselage with four readily accessible bolts. The nacelle containing the Fairchild J-44 engine

is hinged to permit ready access to the interior of the compartment. Like the wing, the tail assembly is attached with four self-aligning bolts.

The normal problems of design for a man-carrying jet airplane were present in development of the drone and, in addition, the complete development of a remote-control system, an autopilot system, and a parachute recovery system were required.

Glide flight tests of the Firebee without power were begun in March, 1951, with the first powered flights made that summer. While the basic research and test program is continuing at Holleman Air Development Center, the Ryan Aeronautical Company is training Air Force and Army Ordnance officers and technicians in assembly, operation, and maintenance of Firebees preparatory to "operational suitability testing" of the drones at several bases.

Diesel-Turbine Plane Engine

A COMBINATION diesel-turbine aircraft engine, called the "Nomad," has been developed by the Napier Company of Britain, according to British Information Services. The

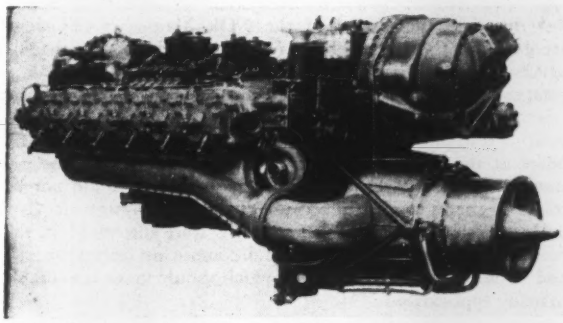


FIG. 2 NAPIER NOMAD COMPOUND DIESEL ENGINE

Nomad compounds the simplest form of two-stroke diesel with a gas-turbine engine. Propeller-powered, the engine is designed for flight over long distances at medium speeds, and is said to be able to fly for more than a day without refueling.

The Nomad is said to operate equally well on diesel oil, kerosene, wide-cut gasoline, or other fuels. It was designed specifically to have the lowest possible fuel consumption under any operating conditions. This it achieves by the use of a high compression ratio, and a high expansion ratio. It enables the same pay load to be carried in a much smaller aircraft than in any comparable turboprop or turbojet plane.

The engine comprises a simple valveless two-stroke diesel engine to which is added a turbine-compressor set. The axial-flow compressor is on a common shaft with a multistage exhaust turbine, and the turbine-compressor set thus formed is coupled mechanically to the compression-ignition engine through suitable gearing. Power is transmitted to a common, single-rotation propeller shaft by a reduction gear in the nose of the engine.

Chief advantages of the compound engine are said to be its simplicity, its low specific fuel consumption over a wide range of altitudes and speeds, and its economy of operation. The low fuel consumption also reduces the proportion of aircraft all-up weight.

Fuel cost is the largest individual item in the direct operating costs of an airplane. Because of this, an aircraft's earning efficiency may be impaired by all sorts of contingencies—head winds, navigational errors, holding time, diversions, and the like. The lower the fuel consumption and the cheaper the fuel consumed, the lower will be the direct operating cost and the greater the profit.

Fuel reserves on the Nomad aircraft amount to only 14 per cent of the capacity payload, as compared to 24 per cent for the turboprop aircraft, and 37 per cent for the turbojet. On a given test run (London-Bahrein), a turboprop machine used 62 per cent more fuel than the Nomad, and a turbojet 120 per cent more. If the Nomad is run on diesel fuel, this advantage is further increased.

The advantages of long-range operation resulting from this saving in fuel consumption are several. They include regularity of operation, since weather conditions barely affect the Nomad engine, safer landing conditions (the smaller aircraft needed with the Nomad requires less runway), and the avoidance of costly maintenance facilities at intermediate stations

A Nomad-powered transport plane would be able to make the London to New York run nonstop in 11.7 hr. This compares with the ten hours' elapsed time for a jet aircraft which would have to refuel at Gander or some other intermediate point.

The Nomad is 9 ft 11 in. in length, weighs 3580 lb for an ehp of 3135, and maintains a specific fuel consumption (over a wide range of altitudes and speeds) of between 0.33 and 0.35 lb per ehp-hr.

Rocket Firing Device

A SECRET rocket firing device in the F-86D Sabre Jet interceptor, which automatically unleashes rockets capable of shooting down the world's biggest bomber with a single volley, was revealed recently by the U. S. Air Force.

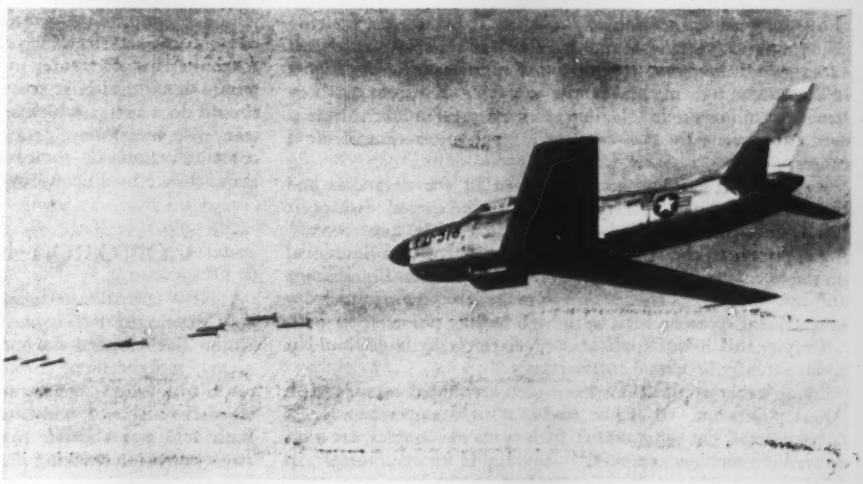


FIG. 3 FIRST PHOTO OF SECRET ROCKET FIRING DEVICE ON NORTH AMERICAN'S F-86D SABRE JET

Designed as a high-altitude, all-weather interceptor for defense of this country, the jet fighter can carry 24 Mighty Mouse 2.75-in. rockets in a retractable launching pod which pops out from the plane's fuselage. Immediately after firing, the pod snaps back into the airplane giving it a streamlined surface for near-sonic flight.

Helping the pilot hunt out and destroy an enemy bomber at night or in any kind of weather, the plane carries more electronic equipment than an average television station. The nation's only one-man interceptor, the F-86D is considered an important part of this country's defense against a sneak air attack. Powered by a General Electric J-47 engine and after-burner, it can take off and climb quickly to extreme altitudes.

Initially, the pilot will be guided to a target area by ground radar. Then powerful electronic beams from his own equipment will lock on the enemy plane. Electronic devices automatically compute range, speed, and probable course of the target. The pilot, who might never see his enemy except as a "blip" or smear on his radar scope, can fire all 24 rockets. A single hit from one of the rockets, which is roughly equivalent to a 75-mm artillery shell, can bring down the biggest bomber. The rockets streak toward their target at approximately 2000 mph.

Gallium Market Wanted

MORE than two years ago Aluminum Company of America, Pittsburgh, Pa., a major gallium producer, widely publicized its properties; yet only a few minor uses have been developed.

To the researcher and the laboratory, the attraction of any rare material, for which no significant use has been found, is great. Gallium is said to be one of these. It melts at about 86 F, but does not boil until 3600 F or higher. Like water, it expands upon solidification. It shows marked differences in electrical resistivity and coefficient of thermal expansion along the direction of the three axes of its crystallographic structure. Its electrical resistivity variability is believed greater than for any other metal. It emits electrons at extremely low temperatures. Thus, combining its unique properties, gallium is truly one of the most unusual elements.

According to Alcoa, exploiting the properties of gallium has been the problem. Some uses exist. It appears in dental alloys for gold restoration work, where it reduces the melting point, increases strength and ductility, and displays other advantages. It has some application as an excitant for phosphors in fluorescent lighting and luminous paint. A patent has been issued for minor use in selenium rectifiers. Gallium chloride is used experimentally as a catalyst for polymerization of vinyl ethers.

Radioactive gallium has been used in the diagnosis and treatment of bone cancer. In spyrochete-caused disease it has definite preventive and curative action. The most promising application, though quantitatively minor, is as a liquid seal on the inlet system of mass spectrometers, where its liquid range and low vapor pressure are said to make it superior to mercury in analyzing hydrocarbons with high boiling points.

Despite this list of applications, relatively little gallium has so far actually been used commercially.

Many other applications have been attempted or suggested, Alcoa points out. It can be used as a high-temperature liquid thermometer, but other means, such as thermocouples, are more convenient and less expensive. As a liquid for manometers, its lower density than mercury should make the instrument more sensitive, but its tendency to wet surfaces and freeze at room temperatures present difficulties. It could be applied as a low-melting-point alloy for fuses and fusible parts, but many systems are satisfied by alloys of cheaper and more readily available metals. Its characteristic expansion on freezing has suggested it as a means to obtain high pressure at low temperatures, and also as type-metal alloys and for investment casting of small parts. A brilliant optical mirror can be prepared with gallium. Application to lithography where surface effect is involved is suggested. High thermal conductivity, low vapor pressure, and thermal stability suggest it as a heat-exchange medium—the problem is to find a nonreactive substance to contain it. Its rich ultraviolet spectrum makes it preferable to mercury in vapor lamps. Since it emits electrons at relatively low temperatures, it should be good for electronic tubes.

While the list of potential uses is great, practical ways to use gallium need to be further explored. Therefore, the "use-wanted" sign is still out for gallium, one of the weirdest performers of the metallic world.

16-Alfenol

A SOFT magnetic material composed of noncritical metals has been developed in the NOL Magnetics Division, according to the March, 1953, *Report* of the U. S. Naval Ordnance Laboratory. Named 16-Alfenol, the new material is composed of 16 per cent aluminum and 84 per cent iron.

The alloy itself actually is not new and has, in fact, been used in several applications by the Japanese during World War II. None of these were completely successful because of the extreme hardness and brittleness of the metal. It could not be rolled in sheets efficiently because of these properties.

However, the metallurgists at NOL were interested in the properties of this alloy, which did contain no critical metals and showed magnetic properties which should make it valuable in many applications.

They finally developed a method for cold-rolling the alloy at 575 C and found that it could be formed into thin tapes showing the desired magnetic properties.

Furthermore, when the NOL researchers got these thin strips, only a few thousandths of an inch thick, they found that the alloy had become tougher and more ductile.

The metal tapes showed isotropic magnetic properties, and a high bulk resistivity which prevented electrical losses. It furthermore "grew" its own insulating layer when rolled, which in some magnetic applications would mean that one step in the fabrication process could be eliminated. The Alfenol strips are lighter in weight than are many of the materials showing similar properties, and, in certain applications, should do a better job than the materials now used. For instance, in transformer cores, like those used in high-frequency communications instruments, it shows properties superior to those shown by silicon iron now widely used.

Corrosion-Resistant Alloy

A NEW corrosion-resistant alloy, Hastelloy alloy F, has been developed by Haynes Stellite Company, a Division of Union Carbide and Carbon Corporation, Kokomo, Ind. A nickel, molybdenum, chromium, iron alloy, developed as the result of a long-range research program, it will withstand the corrosive effects of oxidizing and reducing acids; it can handle both acid and alkaline solutions; it will resist pitting and stress-corrosion cracking in chloride solutions; and it has good hot-working characteristics, according to the company.

Hastelloy alloy F is said to be stronger and about as tough as

the austenitic stainless steels. It is ductile enough for intricate cold-forming operation, but requires more power to deform than do the austenitic stainless steels. Alloy F has good high-temperature properties.

The strength of the alloy does not change significantly after furance cooling from temperatures in the 1000 to 2000-F range. It loses some of its ductility when cooled slowly from 1600 to 2000-F temperatures. Ductility is at its lowest in the 1300 to 1600-F range, and severe hot-forming operations should not be attempted in this temperature range.

In density, the alloy is similar to comparable nickel-base alloys. Its electrical resistance is somewhat higher than 18-8 stainless steel and its thermal expansion characteristics are about 10 per cent lower. It is nonmagnetic. Its modulus of elasticity approaches that of steel. The thermal conductivity of alloy F has not been fully determined, but indications are that it will be about the same as 18-8 stainless steel.

The new alloy can be welded by the metallic arc, inert-gas shielded arc, and resistance-welding methods. Welds made by the metallic arc and inert-gas shielded-arc methods are ductile, and have mechanical properties that are comparable to the base metal.

The alloy has been subjected to more than three years' service in the top vapor zone of a sulphite digester with excellent results. The strong cooking liquor in the digester contained about 10 per cent sulphur dioxide. This test has confirmed the satisfactory nature of the alloy for use where severe pitting conditions exist.

All tests made so far indicate that Hastelloy alloy F offers a remarkable combination of properties for the new pulping duplex processes requiring weak or strong acids, or sulphurous acid, for the first part of the cook, and an alkaline condition for the final part of the cook. Some of these processes start with a ph 4 or lower and end up with about ph 9.

Service tests show corrosion rates of less than 0.001 in. per year for Hastelloy alloy F in both alkaline and acid pulping digesters in either the liquid or vapor phase. These tests cover a variety of pulping woods and cooking conditions. The alloy is especially attractive for service in the vapor phase where corrosion of other alloys has been high.

Semiconductor Material

SCIENTISTS at Battelle Memorial Institute, Columbus, Ohio, report the development of a low-cost material that may compete with germanium and silicon for use in transistors, rectifiers, and other electronic devices.

The potential competitor is a compound of aluminum and antimony. It is one of several that may come from compounds of aluminum, gallium, and indium with arsenic and antimony. Rectifiers have already been produced in the laboratory with the new "semiconductor material" and its use in the making of transistors is a distinct possibility, according to the Institute.

Studies sponsored at Battelle by the Bradley Mining Company, San Francisco, Calif., have shown that aluminum-antimony has electrical properties "at least as interesting as those of germanium and silicon." Furthermore, the new semiconductor material may be superior to germanium, and perhaps silicon, for military uses where operation at high temperatures is required.

Aluminum-antimony is also attractive costwise, it is said. Both components currently sell at less than 50 cents a lb. Germanium sells for about $350 a lb. Raw material cost, it should be pointed out, however, is but a small fraction of the total cost of any rectifier or transistor.

Aluminum-antimony has essentially the same simple, diamondlike structure as silicon and germanium, except that its framework contains two kinds of atoms. Simple structure greatly facilitates the development of methods for the purification and control of semiconductor materials.

Battelle's work on aluminum-antimony has also shown that this material can act as an electric switch under exposure to light, and can be used to convert light to electrical energy. This suggests possible applications of the compound in photoelectric cells for such uses as automatic door openers and number-counting devices on production lines.

Semiconductor materials are so named because they combine the properties of a conductor like copper and an insulator like glass. This characteristic provides them with a natural, built-in mechanism for converting alternating current into direct current when used in rectifiers, and for detecting, transmitting, and amplifying wireless electric signals when used in transistors. Many informed observers believe that, eventually, the transistor will partially replace the vacuum tube in radio, television, hearing aids, and other low-power applications. Transistors may also make possible such developments as portable television receivers and long-distance telephone dialing, where the greater size of the vacuum tube has been a limitation.

Germanium Search

A SEARCH for additional sources of the costly metal germanium for use in radar and other electronic equipment of the Armed Forces has been launched by the Bureau of Mines in ashpits and smoke stacks of large industrial consumers of coal.

The rare element, now produced in the United States in small amounts as a by-product of zinc refining, also appears in minute quantities in many American coals, but at present it is uneconomical to recover directly from the coal. The best method is to extract it from the ash resulting from the burning of coal. The germanium research project is being conducted in the Pittsburgh region at the request of and in co-operation with the Signal Corps Engineering Laboratories at Fort Monmouth, N. J.

The Bureau's search is being concentrated on central-station power plants which burn a total of more than 100 million tons of coal yearly.

Germanium is recoverable from coal ash as a compound that can be converted to metal—its most useful form—by carefully controlled processes. Its most popular uses today are in electronic diodes for rectifying high-frequency circuits and in the recently developed transistors, only a fraction of the size of the smallest electron tube, which they ultimately may largely replace because they are lighter, longer-lived, use less power, and are more compact.

Smaller electronic devices, based almost wholly on the versatility of germanium, mean smaller, lighter, and tougher radio and radar installations for military equipment. A great reduction in the weight of batteries and generators serving germanium transistor circuits also can be expected since such circuits are said to require only a millionth of the electrical power of a comparable vacuum-tube circuit.

Selling at approximately $350 a lb, or nearly 65 per cent the price of gold, all germanium metal used in the United States today is recovered from sludges during the production of electrolytic zinc. The chief supply is the Henryetta, Okla., plant of the Eagle-Picher Company. However, several other companies also are getting into production.

So rare is germanium that only one pound of the element is recovered from every $2\frac{1}{2}$ million lb of zinc ore handled at Henryetta. Annual output is about 6000 lb, but some predict the electronics industry will require 40,000 lb yearly by 1956.

The germanium content of American coals likewise is very low, generally averaging one-thousandth of 1 per cent. At current prices this amount of germanium in a ton of coal has a value of $7 if recovered. Probably only the heavier users of germanium-bearing coals would find it profitable to build plants to recover the element from waste products, such as ashes and flue dusts.

One of the tasks confronting the Bureau of Mines in its hunt for germanium is to develop a standard method for determining the percentage of the element in coal ash and flue dust. Several chemists are working on this, while others are in the field obtaining samples of coal ash from public-utility plants. Later, the Bureau plans research on cheaper germanium-recovery methods from coal products.

Meanwhile Bureau researchers at Rolla, Mo., in the southwestern region are making metallurgical studies of germanium, including its recovery from zinc concentrates.

Although Pittsburgh chemists of the Bureau are concentrating on coal-burning power plants, they also contemplate studies of gas producers as well as blast furnaces as possible sources of germanium.

Versatile Fork-Lift Truck

A 4000-LB-CAPACITY fork-lift truck outfitted with a special carriage and attachments to handle nearly a dozen different types of loads has been developed by The Baker-Raulang Company, Cleveland, Ohio.

Called the "Octopus," the lift truck handles ordinary pallet loads, works as a side-shifting truck to spot loads in "tight" areas and close to columns and walls, hauls and stacks drums and paper rolls, using its clamps, dumps, hauls, and stacks tote-box loads, picks up a variety of pallet sizes after automatically adjusting for proper fork-spacing, empties drumloads of bulk material by hydraulically tilting drums in a vertical plane, and lifts bales of cotton and crude rubber with a new spike-clamp attachment.

FIG. 4 OCTOPUS FORK-LIFT TRUCK SNATCHES UP 500-LB DRUM, REVOLVES, AND UP-ENDS IT AUTOMATICALLY
(Multiple-exposure illustrates variety of handling motions provided by new truck.)

Every plant using fork trucks in its handling system does at least one of the jobs handled by the Octopus. And it usually takes two or three trucks to handle several load-types. Baker engineers think this is the first time one truck does them all.

The assortment of loads is handled nonstop, with just two short pauses for adjustments to the carriage and forks.

The Octopus is a standard battery-powered fork truck equipped with the Baker four-purpose carriage. It uses for attachments: A revolving head (semipermanent), drume lamps, hydraulic drum up-ender, and clamp-spikes (all detachable in two minutes.).

Automatic Contour Lathe

LONG a goal of machine designers, fully automatic contour duplication is said to be an accomplished fact on a giant 60-in. roll-turning lathe that U. S. Steel Corporation recently installed in its Homestead, Pa., roll shop. It is claimed that for the first time on a machine tool of this size, all-electronic duplicating equipment is used to control the tool's cutting action.

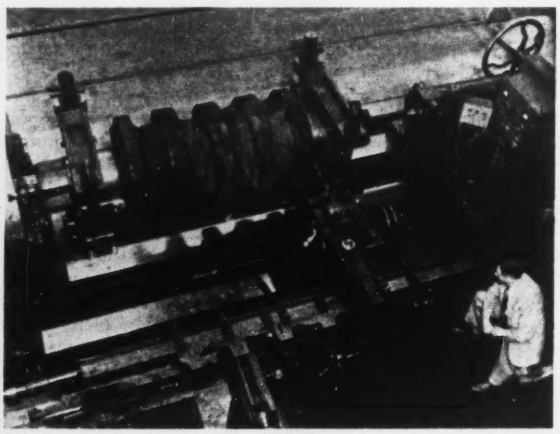


FIG. 5 WORKING AREA VIEW OF 60-IN. AUTOMATIC CONTOUR LATHE
(Flat template on adjustable holder is shown in foreground. Machine is turning a cast-steel shape roll mounted in neck rests. Control panel and cabinet at right houses Raytheon electronic duplicating equipment.)

For the first time, too, it is reported, a lathe of this type is used to generate on huge steel-mill rolls the complex body outlines which produce beams, channels, ship sections, and other rolled-steel products. Deep and narrow grooves, such as a closed flange, necessarily must be cut using tools specially adapted to this work.

Extreme flexibility of its control system and the ease of maintaining the electronic duplicating equipment are major advantages of the lathe. Push-button manual control of all motor-driven tool feeds permits fast roughing of individual passes, and rapid automatic roll finishing.

The duplicating device guides the motion of the cutting tool from a flat template whose contours are exactly those of the roll to be machined in the lathe. A minutely varying degree of angular deflection in a floating tracer stylus moving along the edge of a template is signaled to a control panel.

FIG. 6 CLOSEUP OF CONTOUR LATHE TOOLHOLDER EQUIPPED WITH TUNGSTEN-CARBIDE BUTTON TOOL FOR HIGH-SPEED METAL REMOVAL

(Long and narrow toolholder for deep-groove cutting is specially designed for vibrationless operation.)

These signals are electronically amplified, interpreted, and fed to two electric motors. The motors' combined action in response to the signals keeps the stylus traveling and hugging the template. Since the cutting tool is mounted on the same movable part of the lathe carriage as the stylus, tool travel duplicates the path of the stylus. Tool deflection presents no problem when taking heavy rough cuts. Compensation can be made for tool deflection during lighter, finishing cuts.

Once a job is set up, the lathe operates with a minimum of operator supervision, duplicating on the roll the contours of the guiding template. Roll turning, heretofore, has always been a slow tedious process involving many hours of roughing and finishing time on each roll.

According to Mackintosh-Hemphill Co., Pittsburgh, Pa., designer and builder of the lathe, substantial savings in time and money, machining accurately and quickly, complex steel-mill rolls is expected. At the Homestead roll shop, on one type of roll used to produce structural shapes, the lathe cuts estimated roughing and finishing time from 156 to 49 hr; on another from 196 to 49 hr. Rate of metal removal, discounting setup time, ranges from 2 to 1, to 6 to 1, contour lathe against standard lathe. This naturally depends upon the roll material, which may be cast iron, carbon steel, or alloy steel.

Using tungsten-carbide tools, the unit turns at headstock spindle speeds up to 32 rpm. A standard roll-turning lathe, working with high-speed tools under comparable conditions on the same roll material, would be able to remove metal at spindle speeds between 1 and 4 rpm.

Present roll-shop practice on the new lathe calls for surface speeds of about 60 fpm on iron and 200 fpm on steel.

Additional time and labor are saved by a continuous chip-disposal conveyer which discharges into easily removable buckets in pits at the end of the lathe bed.

Machining rolls, which may weigh up to 35 tons, can present difficult mounting problems. Some of these are solved by mounting the roll solidly in roll housings. The Mackintosh lathe is said to be the first unit of its size capable of contouring rolls while they are supported on their necks—as in the mill—in the special roll housings, rather than turning on centers. Mounted on the lathe bed, the heavy, completely adjustable housings duplicate actual rolling-mill conditions and give stability to the rolls being machined.

The lathe can accommodate rolls up to 54 in. in diam and 20 ft long. Neck diameters from 11 in. to 28 in. can be handled in the roll housings.

Lathe dimensions are as follows: Over-all length, 45 ft; bed width, 65 in.; face plate, 5 ft in diam; headstock length, 9 ft; carriage length on the bed, 6 ft. Main motor is a 75-hp unit.

Regardless of its large dimensions, the lathe is still a precision machine, the company states. Maintenance of extremely close tolerances on steel-mill roll passes can mean longer life for the rolls and consequently less down time for the mills themselves. Rolling-mill experts agree that the closer a roll can be turned to specified tolerance limit, the longer it can be operated between redressings and the better the product it will roll. The fewer the dressings during the roll's life, the more actual time it will see service on the mill.

Mackintosh engineers point out that fast remachining can also mean sizable roll savings because the rolls are out of the roll shop faster and back on the mills. More of their over-all life is spent profitably on the production line, not in the roll shop.

Aluminum Auto Radiators

THE use of aluminum radiators in automobiles is one of many applications now being actively researched by automotive and aluminum manufacturers, according to The Aluminum Association, New York, N. Y.

Aluminum, for many years, has been used extensively in

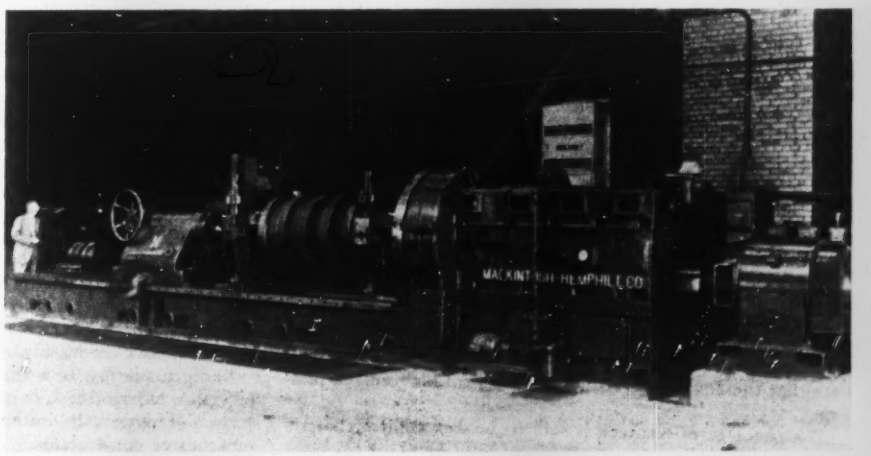


FIG. 7 OVER-ALL VIEW OF 45-FT-LONG AUTOMATIC CONTOUR LATHE SET UP FOR TURNING A CAST-STEEL SHAPE ROLL

(Lathe foundation includes mechanized chip-disposal system. Lathe main motor drive shown at far right is a 75-hp unit.)

trucks and buses where its lightweight means greater payloads, and its resistance to corrosion means longer life with less maintenance. For example, one truck manufacturer has been using aluminum in radiator top and bottom tanks and side columns in the form of castings. Some of these have been in operation for about four years, and to date no failures have been reported.

A survey of leading automotive manufacturers conducted by The Aluminum Association shows that a number of all-aluminum radiators are now in experimental use under service conditions. One large manufacturer, for example, has 35 radiators in use in different parts of the country, and all have been operating satisfactorily for over a year with individual mileages ranging up to 30,000 and more.

Much of the research on this use of the lightweight metal has been aimed toward developing the best method of fabrication. Experience gained with brazed heat exchangers used extensively in aircraft has pointed toward a brazed assembly for automobile radiators. A brazed aluminum radiator can be operated at all cooling-system pressures currently being considered. This characteristic is one which for some time has been in demand by automobile manufacturers. Problems involved in the manufacture of brazed aluminum radiators on a production basis are nearing solution.

Other possible methods of fabrication also are being thoroughly investigated. These include soldering aluminum fins to aluminum tubes or to brass tubes. Developments now are under way to make these methods more feasible.

The favorable long-term prospects of the lightweight metal are causing automotive manufacturers to intensify their development work. On the basis of results achieved so far, the use of aluminum in this essential automotive component is expected to become economically feasible in the foreseeable future.

Nickel Plating

A NEW process of nickel plating, requiring no electrolytic equipment and which greatly stretches the available nickel supply, was revealed recently by the General American Transportation Corporation of Chicago, Ill.

The new process, named "Kanigen," promises remarkable economies in many industrial applications over customary methods, and in addition makes it possible to plate almost any solid substance with a dependable and predictable thickness of a superior, nonporous plate. According to the company, intricate valves and other products previously impossible to plate successfully, can be covered thoroughly; parts subject to hard wear and abrasion may be continuously coated and hardened far beyond the capacity of the parent metal; over-machined parts may be brought back to proper tolerances; parts previously machined of Monel metal and other corrosion-resistant materials can now be of cast steel and plated to a thickness of 3 mils with assurance that the plate will nowhere vary from that thickness—with a consequent saving of expense and critical material.

The process, it is claimed, will plate any article uniformly, regardless of size or shape, and has proved satisfactory for the production-line plating of steel, copper, brass, bronze, stainless steel, and aluminum. Tests on plastics and magnesium indicate that these materials will prove practical for Kanigen plating.

The coverage of Kanigen is said to be so complete that its porosity is virtually zero.

Because of its greater efficiency this new process will provide important savings in critical nickel, which is extremely important in view of the current shortage of nickel. It is estimated that equivalent plate protection can be achieved with one third to one half the nickel required by other processes, partially because of Kanigen's nonporosity, partially because it plates so uniformly that it is unnecessary to overplate in places to assure ample over-all plating, and finally because it takes two or three times more nickel to provide the same corrosion resistance with the electroplating process as is required with Kanigen.

General American originally set out to develop a process for the interior coating of cars designed to carry corrosive chemicals and materials which must not be contaminated by "pick-up iron" from the tank-car metal. Up to this time it has been necessary to finish certain tank-car interiors with several coats of baked-on enamel—a process which is expensive, time-consuming, and lasts only 3 to 5 years. It was believed that nickel plating would prove the ultimate solution, but the continuous electroplating of so large a surface as the interior of a tank car is very difficult under present limitations of the electroplating process.

General American's research group, it was pointed out, succeeded in developing the Kanigen process through the reduction of nickel by the use of hypophosphites, a principle upon which the National Bureau of Standards had done considerable work several years earlier. After the process was perfected in the laboratory, a pilot plant was built in East Chicago in the summer of 1952 and has been in constant service since. Because the throwing power of this process is 100 per cent, it has been found practical for pieces of any shape or size, and will prove eminently satisfactory for its intended purpose—the interior coating of tank cars. This, the company said, will be the next step after construction of presently planned plants. A special unit is to be designed large enough to accommodate tank cars and large vessels as soon as a nickel supply is assured for this purpose.

Kanigen plate is a nickel-nickel phosphide composition. Normal Kanigen platings run about 5 to 8 per cent phosphorus and have a Vickers hardness of 550–650. Its adhesion is said to be excellent. The thickness is astoundingly uniform. Kanigen is usually within 5 per cent of average thickness, while electrolytic nickel can run from 25 to 200 per cent in variations between minimum and maximum. Kanigen's resistance to corrosion far exceeds that of electroplating in similar applications because of its nonporosity and thorough coverage, regardless of size, shape, indentations, or irregularities. In typical applications, even on a large scale, Kanigen is not likely to show any pores even at plating thicknesses of 0.0005 in., hitherto a quality impossible of attainment.

Kanigen is likely to replace some industrial applications of electroplating, but what is more important, it opens up many new fields, thus leading General American to feel that it is one of the most remarkable post World-War developments.

Since neither design nor size offers any complications to the new process, and because of the hardness of the plate, large vessels, tanks, chemical-process equipment, valves, pipe structures, and similar objects can be fabricated of any desirable and easily worked material, assembled, and then given a continuous coating of nickel in whatever thickness is desired. At present this thickness may be controlled when desired to within 0.001 in., and further refinements in progress will, it is felt, reduce this tolerance considerably.

Kanigen plating is a relatively simple straight-immersion process. No rectifiers or motor generators are used. Since racks and hangars do not need to carry current, they can be of inexpensive construction. Very special equipment for maintaining solutions must be provided. All equipment that comes in contact with the plating solution should be acid-resistant—able to withstand temperatures of 212 F indefintely and be non-catalytic to the plating reaction.

The plating vessel should be thermally insulated. Other plating-room operations are similar to those now in use in electroplating, such as, pickling, cleaning, and rinsing.

Originally intended to be an alternate method of nickel plating, the Kanigen process actually has unique properties which remove it from the category of either alternate or substitute. These properties are as follows: (*a*) Throwing power, 100 per cent; (*b*) uniformity of coating, minimum thickness within 10 per cent of average thickness; (*c*) adhesion, excellent: plated-steel test specimens pulled to break point in tensile machine show no flaking or chipping of the plating; (*d*) corrosion resistance of basis metal (20 per cent salt-spray test), excellent; (*e*) porosity (2 hr in clean aerated hot water), virtually no pores; (*f*) hardness range (ordinary), 550–650 Vickers; (*g*) ductility, very low; (*h*) coefficient of expansion, 13×10^6 per deg C; (*i*) electrical resistivity, approximately 60 microhms per cm.

Galvanized-Steel Corrosion

RESULTS of a study of underground corrosion of hot-dipped galvanized-steel pipe, recently completed by the National Bureau of Standards, confirm previous NBS work in showing that galvanized steel having 3 oz zinc per sq ft of exposed surface is highly resistant to corrosion in many soils which are very corrosive to bare steel.

Short lengths of both galvanized and uncoated steel pipe, and also plates of zinc, were buried at 15 test sites for periods up to 13 years. Located in various parts of the United States, the test sites offered a wide range of soil properties. After each of five periods of exposure, a set of specimens of each material was removed and returned to the NBS laboratories. After removal of the corrosion products, determinations were made of loss in weight, depth of the deepest pits, and the percentage of area of the galvanized specimens on which coating remained.

Although the nominal weight of the zinc on all the coated specimens was 3 oz per sq ft, the actual thickness varied over a wide range. This was shown by a large number of thickness measurements made by a magnetic method, using unexposed samples of pipe from the same lot as the buried specimens. Additional determinations by an electrolytic stripping method showed that a large part of the zinc that was applied to the steel pipe was converted into alloys of zinc and iron.

The zinc coatings provided good protection in most of the soils. In one soil in which bare steel pipe was perforated by corrosion after exposure for only a few years, the coating on the galvanized specimens remained perfectly continuous throughout the entire 13-year period. In only two of the 15 soils, both organic, was the zinc coating of negligible protective value.

An interesting discovery was the high corrosion resistance that the galvanized specimens continued to show in most of the soils after the outer zinc coating, and even after the zinc-iron alloy layer had entirely corroded away. This continuing protection is tentatively attributed to an inorganic coating, probably silicious, believed to have been deposited by galvanic action between the outer zinc coating and the underlying steel or alloy layer. This tentative explanation is based in part on unpublished studies which indicate that the zinc-iron alloy layer does not protect steel sacrificially (cathodically), and that the alloy is no more resistant than steel to soil corrosion.

Analysis of the NBS data shows that the minimum weight of zinc coating required to protect steel for a minimum of 10 years depends on the nature of the soil environment. In the NBS studies a 2-oz coating gave sufficient protection in inorganic oxidizing soils, but for inorganic moderately reducing soils a 3-oz coating was required. Highly reducing soils, both organic and inorganic, require coatings heavier than 3 oz per sq ft.

In order to obtain maximum life from galvanized pipe in practice, it is necessary either to construct the entire piping system of galvanized pipe or else to electrically insulate the galvanized sections from pipe of other metals. Otherwise, the zinc coating will be removed by galvanic action.

Atomic Equipment Department

ANNOUNCEMENT by Westinghouse Electric Corporation, Pittsburgh, Pa., of its plans for a new, multimillion dollar plant to produce atomic equipment, has brought atomic power as a commercial business a step nearer reality. The plant will be operated by a newly formed department in the Atomic Power Division—the Atomic Equipment Department.

Believed to be the first major private enterprise of its kind anywhere, the new facility will be located in Harmar Township, near Pittsburgh. At this plant the company will "engineer, manufacture, and sell products that have been developed for atomic power plants," President Gwilym A. Price reported.

"This investment in the commercial future of atomic power is an expression of our belief that private enterprise generally will become an increasingly important factor in the future development and application of nuclear energy in its nonmilitary aspects," Mr. Price declared. "For the immediate future, of course, the products of our Atomic Equipment Department will go to Government atomic projects.

"Westinghouse formed its Atomic Power Division in October, 1948, with a desire to contribute to the nation's defense program. Since that time we have been engaged in development and construction of an atomic power plant for the nation's first atomic-powered submarine, and now also hold a development contract for a similar power plant to drive a large Naval vessel such as an aircraft carrier. This work has been and will continue to be a primary responsibility for Westinghouse.

"Our work during the past four years also has served another useful purpose, however. It has identified the form which atomic power plants will take and the type of equipment which is needed in this field. This Atomic Equipment Department will produce such equipment and thus assure for Westinghouse a position in the coming industrial age of atomic power."

The products of the new plant will be special items which could not logically be produced by existing Westinghouse operations, it was explained in Pittsburgh by Charles H. Weaver, manager of the Atomic Power Division. Although no specific products were named for manufacture by the new plant, it is widely known that the Company's work on the atomic-submarine-reactor project has involved development of many unusual types of equipment. This equipment includes "canned" motors to drive pumps in hermetically sealed systems, and other special-purpose items associated with nuclear reactors and which had never previously been made.

Atomic Power Production

PRODUCTION of useful amounts of electric power by nuclear energy has been achieved from successful operation of a new type of reactor—an experimental homogeneous reactor—at Oak Ridge National Laboratory, the Atomic Energy Commission announced recently.

Scientists brought a pilot-model of the unique reactor system up to its full design power of 1000 kw of heat output on February 24. The reactor steam then was switched to a turbine-generator and about 150 kw of electricity was produced.

This is enough electricity to meet the estimated needs of 50 average five-room dwellings.

Capable of producing both fissionable material and electric power, the small homogeneous reactor was developed at Oak Ridge National Laboratory, which Union Carbide and Carbon Corporation operates for the AEC. However, this reactor was not designed to produce economic electric power.

Project scientists emphasized that many problems remain to be solved, but declared that this demonstration of the feasibility of homogeneous liquid-fuel reactor systems is an important milestone toward economical production of electricity by means of nuclear reactors.

The first demonstration of electric power production by a reactor occurred in December, 1951, at the National Reactor Test Station in Idaho with the operation of the experimental breeder reactor, developed by Argonne National Laboratory.

In the homogeneous reactor, a single homogeneous solution serves as fuel, moderator, and coolant. The heat generated by the nuclear reaction of the uranium fuel in the solution is removed by pumping the hot radioactive liquid through a heat exchanger or boiler which produces steam to drive a turbine-generator.

A homogeneous-type reactor was built in 1944 at Los Alamos Scientific Laboratory in New Mexico, and another is nearing completion at North Carolina State College. However, these units are low-power research reactors. The one at Oak Ridge is the first to operate at a temperature and power high enough for production of steam to run a standard industrial turbine-generator.

The AEC reported that after an 11-month period of thorough testing, the Oak Ridge experimental homogeneous reactor went smoothly to full power. For the first short period of top-power level operation, the reactor produced twice as much electricity as needed by its own building, and the excess electricity from nuclear energy was fed into the Oak Ridge National Laboratory electrical system.

Construction of this reactor at Oak Ridge was started in March, 1951, following two years of development and design by Oak Ridge National Laboratory scientists. The reactor "went critical," or first achieved a nuclear chain reaction, on April 15, 1952. Following the low power operation, the experimental work will continue at higher power to acquire information regarding the feasibility of this type for full-scale reactors.

The homogeneous reactor experiment is housed in a sheet-metal, barn-type building situated in a small valley adjacent to Oak Ridge National Laboratory. Construction and fabrication of the reactor and its auxiliaries, including building and site facilities, cost about $1,100,000; cost of research and development was approximately $3,000,000.

Successful operation of the homogeneous reactor climaxed a $2^1/_2$-year effort by a group of Carbide chemists, engineers, and physicists under the direction of Dr. J. A. Swartout.

Robot Psychologist

A HUGE $2^1/_2$-ton, double-section electronic computer, known as a psychological matrix rotator, has been developed at the General Electric Company's General Engineering Laboratory, Schenectady, N. Y., from a basic design prepared by Dr. Richard H. Gaylord, Department of Defense psychologist.

This "robot psychologist" is being used by the Personnel Research and Procedures Division of the Adjutant General's office in Washington, D. C., to assist in placing the right man in the right Army job.

The machine is said to be so complex that only skilled psychologists can operate it and understand results.

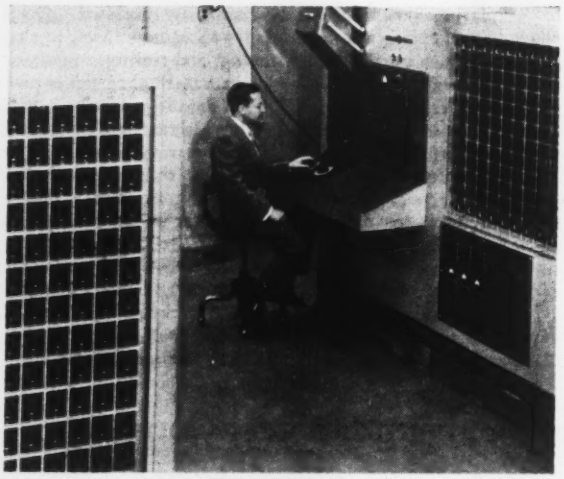


FIG. 8 THIS HUGE, $2^1/_2$-TON ELECTRONIC COMPUTER IS HELPING ARMY PSYCHOLOGISTS AT THE PERSONNEL RESEARCH PROCEDURES DIVISION OF THE ADJUTANT GENERAL'S OFFICE "SEE" THAT THE RIGHT MAN GETS THE RIGHT ARMY JOB

Psychological problems are first translated into statistical form and then fed into the giant computer. A maze of vacuum tubes, potentiometers, wires, and other electrical apparatus literally hums through the data and flashes results on a cathode-ray tube, similar to a 16-in. TV viewing screen.

The operating psychologist sees the test results in the form of "scatter diagrams" or dot patterns. Data not required during a particular problem are stored in the machine's electronic "memory" for future use.

G-E engineers say time required for solving complex problems can be reduced from months or even years to a matter of days through use of the new computer.

A step-by-step account of the machine's use in a typical problem might run as follows:

Psychologists first obtain information to be fed the machine by administering paper-and-pencil tests to various "known" groups of people, such as doctors, truckdrivers, or mechanics. Each group is assumed to have individual talents or abilities as manual dexterity, shape recognition, reasoning, etc.

Information thus received is translated into statistical form on a variety of other computing devices and fed into the robot psychologist for analyzing. A myriad of buttons, switches, and dials set the computer into operation to flash test results on the viewing screen as a pattern of dots. The dot patterns are then studied for desired information.

Dots obtained from statistical data of known groups are then used as a standard of comparison in determining what specific qualifications are needed for a particular job. The patterns can then be used in mass psychological testing of new recruits.

The psychological matrix rotator was developed to handle statistical data representing 12 different abilities underlying up to 50 tests. However, Department of Defense psychologists have already learned to adapt it to much larger problems.

Test patterns arranged in closely clustered dots are assumed to describe similar underlying or inherent abilities among the various groups, such as both doctors and mechanics having manual dexterity.

Whenever a dot representing a particular test of ability is widely separated from the cluster, the operator identifies the dot by lighting a circular light around it. Then by cross-

checking the robot psychologist, he can tell which test or ability is under question.

Such an occurrence might indicate, for instance, that the test under question is not accurately representative of the clustered dots. For example, a dot representing spelling ability or test might be widely separated from dots representing mathematical ability, with which spelling has little in common.

The giant computer comprises two sections. A 5 × 5 × 6 ft input cubicle contains electronic equipment for receiving and storing statistical data. The operator's console, approximately twice this size, but stationed 6 ft away, consists of controls for receiving information from the input cubicle, the computing elements, the viewing screen, and a camera for photographing "cluster" data.

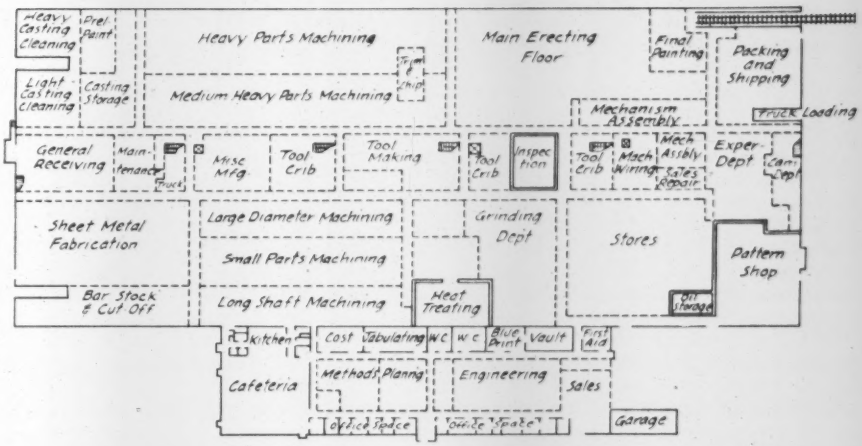


FIG. 9 DEPARTMENT LAYOUT OF NORTON COMPANY'S NEW GRINDING MACHINE DIVISION

Grinding-Machine Plant

A NEW modern $6,000,000 grinding-machine plant was unveiled recently by Norton Company in Worcester, Mass., and inspected by members of the technical press. Built to meet the demands of the present defense effort, the plant consists of a 740 × 300-ft factory and a 360 × 100-ft office building.

Features of the new plant are straight-line production methods, new modern machine tools, special materials-handling equipment, air-recirculating dust-control equipment, forced ventilation providing three complete air changes per hour, and many others.

Supplies and raw stock are now received at one end of the plant and progress through five 60-ft bays toward the final assembly floor and shipping area.

The first line is for processing of heavy castings such as grinding-machine bases, wheel slides, and other heavy parts.

Line 2 is for processing medium-size castings such as grinding machine tables, head and footstocks, aprons, and manifolds.

The third line is for processing large-diameter miscellaneous parts such as gear pulleys, wheel sleeves, and adapters.

Line 4 is for processing of miscellaneous small parts such as studs, small gears, pistons, valves, and pump worms.

Line 5 is for processing long parts such as wheel spindles, feed screws, and shafts. A heat-treating department is located in line 5 because the largest volume of material routed to this line specifies heat-treating. Most of the operations necessary to finish a part after heat-treating require grinding operations. Therefore grinding machines have been located at the north end of all three production lines.

Each line contains special machine tools such as thread grinders, thread millers, gear cutters, and boromatics. These machines are positioned in line so that parts can move from all three lines to these special operations.

FIG. 10 GENERAL VIEW OF ONE OF THE FIVE MANUFACTURING BAYS OF NEW NORTON GRINDING MACHINE DIVISION PLANT

(Note that craneways of floor-operated cranes are supported independent of the building structure. Bus ducts and steam lines run between crane and building columns. Alundum aggregates have been added to the concrete in the aisles as a nonslip feature. A specially designed lighting system provides 40 to 60 foot-candles at the working level.)

All of the parts are processed on a dating system of control by operations. The cycle is set at 1½ days, plus machine time per operation. When the parts are finished they are delivered to stores in accordance with the required date.

The stores department accumulates the parts and applies them to assembly and equipment order numbers in a "reserve area," where special racks are used to handle material. When the schedule requirements are complete, the parts are delivered to mechanism assembly. The various operations required to complete the mechanisms are performed. The mechnisms are inspected, tested, and those mechanisms applied to specific machines are delivered to the erecting floor. The other mechanisms applied to standard-lot quantities are returned to stores for future application.

The heavy parts are located in specific lines on the erecting floor and the operations of assembling mechanisms, electrical controls, and tooling equipment are performed to produce a finish grinding machine. When the grinding machines are finished, they are inspected, tested, and run off on the erecting floor.

For painting, the finished machine is moved to Roto-Wash water-curtain paint spray booths with downdraft gratings which eliminate need for respirators. These booths, of the latest type, recirculate 3600 gal of water, and 40,000 cfm of air pass through the gratings at a velocity of 150 fpm. From here the machine is moved to the packing and shipping area. The exposed surfaces are prepared with a corrosion preventive. The machines are secured to wooden skids and rigidly supported for transportation protection.

Typical examples of the savings in handling are these: 554 ft of travel against 3140 ft for a heavy grinding-machine wheel slide; 896 ft against 4900 ft for wheel spindles. These savings are typical of all machine parts. It is estimated that handling distances have been reduced 50 to 90 per cent. Much of the materials handling formerly done by electric trucks is now done by floor-operated cranes supported on craneways independent of the building structure. Hand trucking between machines has been reduced to a minimum. There are several receiving and shipping platforms easily accessible to motor trucks.

Straight-line production, Norton engineers said, greatly simplifies the problem of quality control and expediting. As a result of more efficient methods, it is expected that delivery dates can be substantially shortened.

Low-Frequency Heating

USING ordinary household electric power, Aluminum Company of America has succeeded in heating a 7700-lb aluminum ingot to working temperatures, nearly 15 times faster than it could be done in a conventional furnace. This announcement came from Donald I. Bohn, Alcoa's chief electrical engineer.

Mr. Bohn said the new technique of 60-cycle induction heating will be invaluable in heavy-press production of big aircraft aluminum forging and extrusions.

Until this low-cycle method was developed, Alcoa used conventional methods, such as soaking pits or other furnaces, in all its operations to bring ingots to proper forging or extrusion temperatures.

Heating a 7700-lb aluminum ingot to 750 F by conventional means requires about 12 hr, as compared with the 50 min for the low-frequency induction method.

The new method consists of placing an unheated ingot in a specially designed electric coil.

Electric energy of commercial frequency is then applied to the coil. The electric current flowing through the coil induces a heavy current in the ingot itself, and this produces the temperature rise in the metal.

When Alcoa first started work on low-cycle induction heating, low-frequency coils were considered impractical and inefficient. Induction heating then used only current of higher than commercial frequencies, requiring expensive conversion equipment.

Alcoa's first work was with 9600-cycle coils. As experiments continued, 1000-cycle coils were used, then 360, 180, and finally, 60 cycles, the same frequency as household current.

With each successive drop in frequency, Alcoa was able to improve, rather than decrease efficiency.

Mr. Bohn said Alcoa's low-cycle induction-heating method compares favorably with installation and operating costs of conventional equipment.

Induction heating, he added, permits use of equipment smaller than conventional methods require. The induction-heating method provides increased flexibility in operation of big forging or extrusion equipment.

Mr. Bohn said the coil also can be used for annealing and heat-treating fabricated products.

Ultraviolet Photometer

AN ultraviolet photometer which can be used to detect minute concentrations of gases is the latest tool perfected by Du Pont scientists to aid in the control of atmospheric pollution. The instrument, described by Daniel J. Troy of the Du Pont Company, before the recent national meeting of the American Chemical Society in Los Angeles, Calif., operates by measuring the decrease in intensity of a beam of ultraviolet light when the contaminated atmosphere is allowed to pass through a transparent vessel mounted in the beam. A refinement of an instrument developed by Du Pont some ten years ago, a new method of calibration and modifications of design have greatly extended its range of sensitivity.

The absorption of ultraviolet light has been used for many years as a method of chemical analysis. The chief problem arises from the high degree of sensitivity that is required. The ultraviolet-light photometer can detect a decrease in light intensity amounting to one part in 10,000. By way of comparison, the human eye can detect a decrease in light intensity of one part in 100 and is thus 100 times less sensitive.

To put it another way, this degree of precision is equivalent to detecting at a glance the loss of two drops from a quart of milk or one lump from half a ton of nut coal. With this sensitivity, the instrument can detect concentrations of benzene, bromine, carbon disulphide, nitrobenzene, ozone, sulphur dioxide, and tetrachloroethylene, to name but a few that are well below the established industrial-hygiene safety limits for eight hours' exposure.

The photometer is conveniently portable and can be used in any area where 110-volt electric power is available.

A difficult problem in the application of this analyzer, or any analytical method for the detection of extremely low concentrations of gases, is the method of checking the calibration. The obvious method of mixing a small measured amount of the gas or vapor with a large chamber of air will frequently give erroneous results because of the tendency of many compounds to be adsorbed on the surfaces of solid materials.

A new method of calibration overcomes this problem through the use of a special gas-mixing apparatus by means of which samples of air containing known low concentrations of gases are prepared continuously. Continuous preparation of the mixture effectively eliminates errors due to the adsorption of the vapor.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Machine Design

An Investigation of Cemented Tungsten Carbide as Bearing Material, by J. S. Kozacka, Mem. ASME, University of Illinois, Chicago, Ill., H. A. Erickson, Mem. ASME, D. A. Stuart Oil Company, Chicago, Ill., H. W. Highriter, Vascoloy-Ramet Corporation, Waukegan, Ill., and A. F. Gabriel, Acme Industrial and Acme Scientific Company, Chicago, Ill. 1952 ASME Annual Meeting paper No. **52—A-45** (mimeographed; to be published in Trans. ASME).

THERE have been many inquiries for application of cemented tungsten carbide as bearing material in designs where high pressures exist and where lubrication is a problem. Considerable interest exists in application of cemented tungsten carbide to precision-grinding spindle bearings, where the life of other bearings is short, a factor resulting in excessive replacement time. To test the feasibility of using cemented tungsten carbide as bearing material, a research project was organized by the Vascoloy-Ramet Corporation, the Acme Industrial Co., and the D. A. Stuart Oil Company. Tests were arranged and co-ordinated by Prof. J. S. Kozacka.

This paper is the first progress report of an investigation to measure cemented tungsten-carbide-bearings performance using different lubricating oils under varying load conditions.

Objectives of the tests were first, to determine whether properly lubricated bearings made of cemented tungsten carbide with journals made of the same material, can be run together; second, to find the coefficient of friction under different speeds, loads, and type of oil used; and third, to evaluate the wear characteristic and surface-finish deterioration.

Based on the data in this report, it is concluded that a cemented tungsten-carbide bearing with the journal made of the same material can be run successfully under proper lubricating conditions at a considerable sustained bearing pressure. Indications are that lubricated cemented tungsten-carbide bearings have frictional characteristics similar to those of bearings made of other materials.

In these tests it was found that under similar test conditions the bearings and journals with the finer surface finishes gave the better performance.

Comparative tests run with the cemented carbide bearing and a similar bearing made of drill rod using kerosene as the lubricant, gave results showing the cemented carbide bearing to be approximately five times more abrasion-resistant than the drill-rod bearing.

Tests with a cemented tungsten-carbide bearing and a similar bearing made of drill rod, running without lubricant, at 884 psi gave one-half minute time for the cemented carbide bearing before failure was noted, and immediate failure for the drill-rod bearing. This test indicated that cemented tungsten-carbide bearings cannot be run dry under conditions where a considerable bearing pressure exists.

Within the time consumed in these tests, no evidence was found of chemical deterioration of the cemented-tungsten-carbide bearing surfaces due to the use of extreme pressure material incorporated in the lubricants.

Beneficial effects obtained through the use of extreme pressure materials to reduce frictional resistance are best demonstrated in the roughly finished bearing. However, the safety factor which would prevent damage because of accidental overload warrants their use even on the highly finished surface bearings.

Appearance Comes in Three Shades, by M. W. Papp, The Warner & Swasey Company, Cleveland, Ohio. 1952 ASME Annual Meeting paper No. **52—A-47** (mimeographed).

THE appearance of a machine or machine tool depends on its styling and shape, and the eye-attracting characteristics of its visible surfaces, according to this paper. As shape is created in the design process and is seldom modified during manufacture, the machine builder's real problem is the control of surface characteristics. While machined surfaces present no difficulties, the remaining visible areas, usually painted, create problems in standardizing appearance.

The three most pertinent qualities of a painted surface are color, smoothness, and luster. Color is not a problem to machine builders, as the color characteristics of paints can be measured and

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rigidly controlled by paint manufacturers. But smoothness and luster are dependent on many factors, such as surface preparation of parts to be painted, before assembly, and choice of the most critical parts from an appearance standpoint.

In an effort to stabilize painting costs and to establish uniformity of appearance, the author's company made a study which resulted in a set of standard specifications and appearance guides. First, it established the four preliminary operations, known as "process painting," in the preparation of surfaces before assembly. Although only one of the procedures is related to appearance, all were assigned identifying symbol numbers (P4, P5, P6, and P7) and now appear as a part of the established specifications on detail drawings.

The symbol P4 denoting "appearance" quality is now specified for all parts open to view after assembly. Inspectors and painters have access to a cast-iron sample prepared according to suggested procedure.

The P5, P6, and P7 symbols cover painting applications of a special nature pertaining to the treatment of interior surfaces for oil and corrosion resistance and sealing purposes.

Standard painting specifications and procedures supplemented by appearance guides have now eliminated virtually all of the appearance controversies at the author's company. Furthermore, within a year after painting standards were adopted, painting time for most machines was reduced more than 50 per cent, and appearance was actually improved. Where the largest sizes of machines required 45 hours before standardization, they now are painted in 19 hours.

Building Large Dragline Excavators, by P. H. Woods, Jun. ASME, Bucyrus Erie Company, So. Milwaukee, Wis. 1952 ASME Annual Meeting paper No. 52—A-112 (mimeographed).

ELECTRIC-POWERED 1500-ton walking-dragline excavators economically remove overburden to uncover deep-lying coal and mineral deposits in open cuts. Problems arising in the production of this type of machinery, many components of which are beyond the capacity of commercial machine tools, are discussed in this paper. Typical procedures with regard to unusual size include the cutting of 24-ft-diam gears and the machining of circular rail segments on a planer, checking the alignment of machinery components with a surveyor's level, and utilizing specially designed portable machine tools for the completion of units too large to machine by conventional methods. Draglines must be designed for sections small enough to be shipped by rail for field assembly, more than 60 carloads being needed in transporting all the components for a single machine.

Today's 30-cu yd dragline is designed and operated as one machine. But because of size problems it is arranged in units several of which go into each major component. After major components are temporarily assembled and checked in the plant these are dismantled for rail shipment in such ways as to permit accurate assembly welding and some finish machining on location at an open pit mine.

Industrial Instruments

Analogies for Hydraulic and Electric Drives in Servomechanisms, by Yaohan Chu and Leonard A. Gould, Massachusetts Institute of Technology, Cambridge, Mass. 1952 ASME Annual Meeting paper No. 52—A-101 (mimeographed; to be published in Trans. ASME).

THE analogy method in engineering is used to great advantage in those cases where a body of knowledge has been built up in one particular field but not in another. If one finds identical mathematical descriptions of two superficially different physical systems, it is said that the systems are analogous. Thus, if one system has been thoroughly studied on the basis of its mathematical description (differential equations), the analogous system is much more readily engineered by using the accumulated knowledge already available rather than by studying the same mathematics all over again.

This paper demonstrates the analogy between the d-c electric and hydraulic drives, commonly used in servomechanisms.

The analogy is developed from their analogous basic relations, and their analogous methods of speed-control are then shown. The analogous dynamic behavior of such servomechanisms are shown both in the derivation of the respective electric and hydraulic circuits and in the block diagrams.

One distinguishing nonanalogous character is that there is no hydraulic analogy to the mutual flux of electric machines. Nevertheless, it is shown that analogous dynamic behavior of the servomechanism resulting from an advantageous flux compounding in the electric drive can be achieved by applying certain pressure feedback in the hydraulic drive.

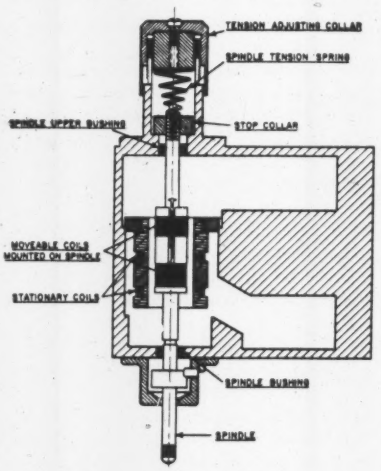
Production Engineering

Gaging and Sorting Electronically, by Albert C. Sanford, Federal Products Corporation, Providence, R. I. 1952 ASME Annual Meeting paper No. 52—A-111 (mimeographed).

MANAGEMENT generally considers inspection as an expensive nonproductive function. The use of completely automatic inspection machines reduces costs and improves inspection accuracy. This paper explains some of the principles employed in designing and building automatic gages. It gives an illustrated explanation of several types of measuring devices, a brief discussion of the electronic circuits, and gives a number of examples of existing gaging machines, showing and describing their application to typical problems.

The simplest of these measuring devices is the electrical contact or switch type which generally incorporates a spindle similar to that of a dial indicator. Changes in the size of the workpiece move the spindle and this in turn actuates switches. Operation of the switches, one of which is usually provided for the high limit and one for the low limit, sets up electrical circuits which can be used to control disposal traps and auxiliary equipment.

Electromagnetic-mechanical and elec-



ELECTRONIC-MECHANICAL-TYPE GAGE

(100,000-cycle current passing through the moveable coil is induced into the stationary coils, the amount being in accordance with movement of the spindle and size differences in parts.)

tronic-mechanical types of gages look somewhat similar. As a piece is moved in under the spindle of either type gage, the spindle moves and the change in size is shown on a meter.

In the electromagnetic gage the spindle generally moves an iron core between a couple of coils. This type of gage is generally run with 60-cycle current flowing through the coils. The electromagnetic type of gage can be made extremely sensitive and with very high magnification. It is not uncommon to find such gages with scales graduated in millionths of an inch.

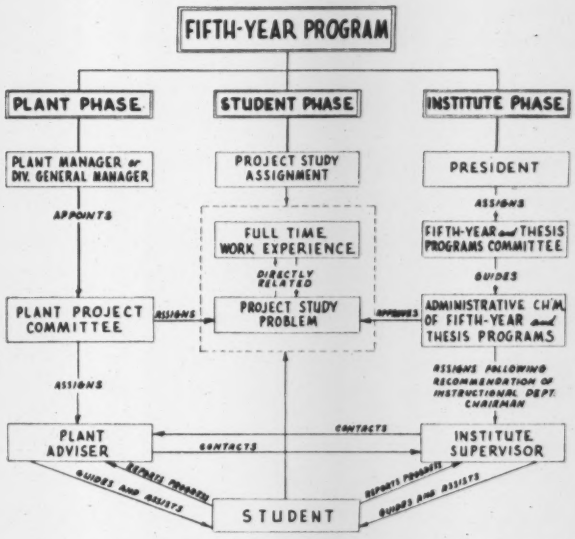
The electronic-mechanical type, which again is familiar in the form of a comparator, looks somewhat the same as the electromechanical type, but it does have some important differences. In this type of gage the moveable coil is attached to the spindle and two fixed coils are fastened to the gage head casting. Movement of the spindle, in accordance with size differences of the parts, changes the relative position of the spindle coil to the fixed coils.

This discussion is concerned with taking parts which have been produced at some process or other, bringing them over to an automatic inspection machine and sorting them out. While this is certainly an improvement over the old hand methods, even this procedure can be improved. The first goal should be to bring the gage right to the machine and have the parts come from the manufacturing operation right into the sorter and then be packaged. Even better than this, on those processes which are suitable for such control, would be to mount the gage right on the production machine and have it automatically adjust the machine so that all parts are manufactured within the required tolerance and no further sorting is necessary.

The Fifth-Year Program and Its Effect Upon the Professional Development of Young Engineers, by Charles L. Tutt, Jr., Mem. ASME, General Motors Institute, Flint, Mich. 1952 ASME Annual Meeting paper No. 52—A-132 (mimeographed).

IN presenting the General Motors Institute Fifth-Year Program and its effect on the professional development of young engineers, this paper first gives a picture of the operation of the program and analyzes seven years of experience with the program and the professional development of the men who completed it.

Upon completion of the Four-Year Co-operative Engineering Program a General Motors Institute graduate is awarded a diploma indicating that he has completed all residence requirements leading to a bachelor's degree.



GRAPHICAL PRESENTATION OF GENERAL MOTORS INSTITUTE FIFTH-YEAR PROGRAM

Before his degree is awarded the recipient of a diploma must show proof that he is capable of using the knowledge the degree signifies. Thus a graduate may submit proof that he has the professional knowledge that the degree signifies by completing either the Fifth-Year Program following graduation or the Thesis Program at a later date.

The Fifth-Year Program was established effective with the class of 1945, as a continuation of the Four-Year Cooperative Program. Fundamentally, the program recognizes that the year following graduation is a critical period in the life of any graduate, since he faces a change in his status from that of a student to one of a full-time employee in an industrial organization. The graduate, therefore, has the opportunity to make his transition successfully during this period in which his professional development is no longer planned and supervised but guided to allow the graduate's self-development in an organization. The program also allows the student to give definite proof that in addition to his academic proficiency he has the ability to apply knowledge gained during his Four-Year Cooperative Program to actual industrial problems as encountered in an operating organization.

The Fifth-Year Program consists of the following three phases:

The plant, the Institute, and the student.

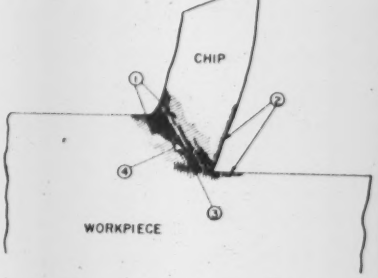
Metal-Cutting Data

Workpiece and Surface Temperatures in Milling, by A. O. Schmidt, Mem. ASME, Kearney & Trecker Corp., Milwaukee, Wis. 1952 ASME Annual Meeting paper No. 52—A-86 (mimeographed; to be published in Trans. ASME).

RECENT investigations have shown that metal cutting involves many problems of heat flow, temperature distribution, friction, and behavior of metals which are unique and complex. This paper reports mainly the state of workpieces with respect to sensible heat. The temperature gradient in workpieces while being milled and the existence of very high instantaneous surface temperatures during the cut have been determined experimentally.

Instantaneous workpiece-surface temperatures, which are much higher than measured tool-tip temperatures, can occur in a metal-cutting operation.

Surface temperatures depend upon the



HEAT SOURCES DURING CHIP FORMATION (1, Due to compression; 2, due to friction; 3, due to tear; and 4, due to shear.)

workpiece material being machined. Those materials which require more power under otherwise identical conditions of speed, feed, depth of cut, and tool angles will also have higher temperatures at the surface and in the workpiece.

Maximum surface temperature is lower with decreased cutting speeds. At the same time the temperatures within the workpiece are higher because a larger percentage of heat flows into the workpiece at the slower rate of separation of chips.

Extremely high cutting speeds in steel milling and in machining of other high-strength materials cause rapid deterioration at the cutting edge and therefore very high temperatures at the machined surface. This often results in warpage of the workpiece.

Fuels

Recent Developments and Progress in Air-Pollution Abatement, by Allen D. Brandt, Bethlehem Steel Company, Bethlehem, Pa. 1952 ASME Annual Meeting paper No. **52—A-70** (mimeographed).

TODAY industry is making great strides in abating atmospheric pollution, this paper states. No great change will be noticeable overnight, however, as this is a tremendous job which must be undertaken on a long-term basis. The amount of money being spent currently on corrective measures is enormous, and is expected to increase. Independent studies by two concerns indicate that the current rate of expenditures on air-pollution-control equipment is in the order of $100,000,000 annually.

Engineering control of air pollution may be approached by four different avenues, the paper states. These are substitution, conversion, retention, and dispersion. A fifth avenue of pollution control, odor masking, might be added in limited instances where nontoxic, odoriferous materials are evolved. An example of odor masking is the use of several industrial odorants or masking agents for modifying and abating malodors released during the manufacture of kraft pulp in paper mills. Several large paper mills in the South have recently started using industrial odorants to improve the odors in the back liquors and waste waters. Odor masking does not result in decreased discharge of odoriferous air pollutants, but it may alleviate undesirable conditions when other more positive methods of control cannot be found.

Substitution of a machine or material that produces or releases less polluting material is an effective procedure, but very limited in scope. Examples are the substitution of diesel locomotives for coal-burning ones; the substitution of gas or fuel oil for heating domestic, public, or other buildings; the use of slag covers on pots or furnaces containing molten metals of all kinds; substitution of low-volatile solid fuels for high-volatile ones such as bituminous coal having a volatile content of not more than 23 per cent for that having a higher volatile content; and the substitution of stoker-feed for manual-feed equipment. These changes alone have contributed remarkably to air-pollution abatement in such places as St. Louis, Pittsburgh, Nashville, and Cincinnati.

Conversion likewise is rather limited in scope. Examples are converting the hydrogen sulphide in waste gas from oil refineries and coke-manufacturing plants to sulphur dioxide, converting sulphur dioxide to sulphuric acid; converting the carbon monoxide in waste blast-furnace gas to carbon dioxide by burning; and converting certain other carbonaceous solids and odorous and obnoxious gases to less obnoxious pollutants by burning.

By retention is meant the removal of a substantial percentage of pollutants from excessively contaminated air and gases discharged to the atmosphere through stacks, or otherwise escaping to the atmosphere. It is for equipment of this kind, filtering or collecting equipment, that the bulk of the money probably will be spent. It is unfortunate that the collected materials in many instances have little if any monetary value, making the capital outlay for such equipment almost a total direct economic loss.

Some of the conventional collectors such as cyclones, multiclones, dynamic precipitators, and many wet collectors are not extremely costly but they are not very effective, either, especially against small particles. It is not hard to remove material of 10 microns and larger from an air stream, but when most of the pollutant by weight is smaller than one micron and in some instances smaller than one-half micron, as is frequently the case in metallurgical furnaces, its retention is extremely difficult.

Electrostatic precipitators, baghouses or fabric collectors, and certain special wet collectors can be made to separate the very fine dust from an air or gas stream with a high degree of efficiency, but the cost of such equipment is great—sometimes prohibitive—and in the case of fabric collectors there is a limitation as to the temperature of the gas that may be handled.

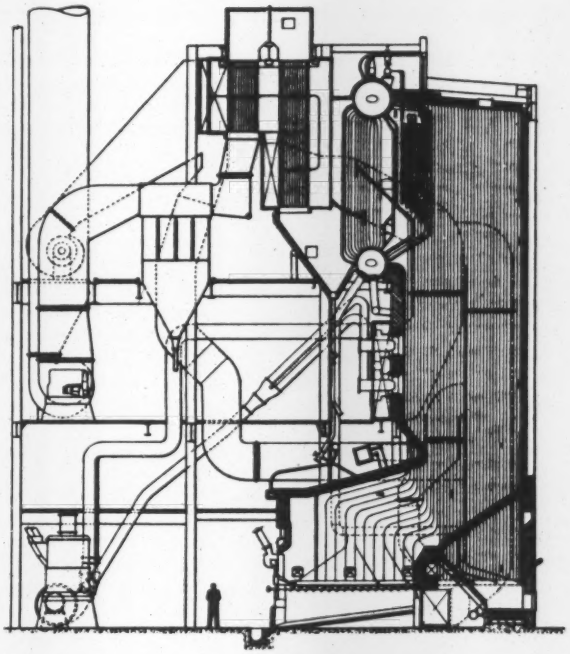
The fourth method of controlling air pollution is dispersion—reducing the concentration to an innocuous level by dilution or mixing in the atmosphere. The method is applicable to any type of pollutant, but it is more suitable for gaseous contaminants than for solid ones, especially if the particle size is large. Much research has been done on the dispersion of smoke and gases from chimneys and has resulted in the development of equations, curves, and data from which the minimum stack height may be determined. The information available illustrates rather convincingly that tall stacks have very beneficial effects in dispersing the air contaminants from factories. The maximum ground concentration varies inversely with the square of stack height.

Turbulent Suspension Burning of Wet Wood, Bark, and Other Fuels, by Otto de Lorenzi, Fellow ASME, Combustion Engineering-Superheater, Inc., New York, N. Y. 1952 ASME Annual Meeting paper No. **52—A-104** (mimeographed).

DURING the ASME Semi-Annual Meeting at San Francisco in June, 1949, preliminary development work and test results on single-stage furnaces, burning wet wood, were discussed. The design, employing the principle of suspension burning, has now been refined. At present several units are in various stages of construction, while an additional one has been in continuous service for a period of over 14 months. Considerable operating data, covering a wide range in capacity, while burning wet wood-room refuse, fuel oil, and high as well as low-volatile coals are now available.

Turbulent suspension burning may be defined as the principle of showering particles of solid fuel downward, from some considerable height in a towerlike furnace, through relatively large quantities of highly turbulent gas and overfire air to effect: Flash drying; partial or complete devolatilization; ignition of residual fuel constituents; and finally, uniform distribution of the residual fuel to the grate surface, in the lower furnace zone, where combustion is completed through the use of reduced quantities of undergrate air.

Location of fuel distributors in furnaces employing the principle of real turbulent suspension burning is at an elevation of from 12 to 20 ft above grate level. Overfire-air jets are located in the furnace corners between feeder and grate levels. With this arrangement it becomes possible to use large fuel particles, because they are spun around in flight by the overfire-air streams and thus retained in the rising column of burning gas for a greater length of time before coming to rest at grate level. It is this increased



LARGE UNIT WITH TWO-STAGE FURNACE FOR BURNING WOOD-ROOM REFUSE, PULVERIZED COAL, AND FUEL OIL

time of flight through the hottest furnace zone that provides for flash drying, partial or complete devolatilization, and ignition of residual fuel constituents. Slug feeding produces no noticeable changes at fuel-bed level, and consequently there are no adverse effects to operating results.

Some of the more important operating characteristics of turbulent suspension burning are briefly discussed. As more and more units are placed in service, many additional factors will be accurately established. Design will be modified to take every advantage of improvement in the art.

The development of this unit and its auxiliaries has advanced bark refuse to the role of a low-cost substitute fuel capable of supplying steam to the power plant header through the medium of the more dependable steam generator.

Throughout the discussion of turbulent suspension burning, reference is made to a design heat-release rate of 1,000,000 Btu per sq ft grate surface per hr without setting up any limiting factors. Selection of the actual rate to be used for specific designs is influenced by fuel size. Any considerable increase in size of the larger particles will make it necessary to carry out a greater portion of burning at grate level and, thereby, reduce the quantity of air used overfire. In turn this may simultaneously lower effective turbulent suspension burning. Consequently a range of from 900,000 to 1,100,000 Btu per sq ft will prove adequate for usual variations in fuel size encountered.

These higher heat-release rates make it possible to design steam-generating units on a more economical basis because of the possible increase in capacity per foot of furnace width.

Present-Day Thoughts on the Application of Single-Retort Underfeed Stokers, by D. J. Mosshart, Mem. ASME, Westinghouse Electric Corporation, Philadelphia, Pa. 1952 ASME Annual Meeting paper No. **52—A-103** (mimeographed).

IN numbers, the single-retort underfeed stoker continues as an important factor in the field of coal-burning equipment because of low over-all cost of installation, the paper states. Improvement in performance is possible at an increase in cost. Greater care in working out details of application and in establishing control of operation will pay good dividends in over-all economy and abatement of smoke and dust emission.

For normal load below 25,000 lb of steam per hr or low-load factor with capacity up to 35,000 lb per hr, where investment costs must be kept low, and where stack discharge must be minimized, the single-retort stoker is a logical choice for burning bituminous coal. It provides: (1) Minimum over-all cost of boiler and stoker; (2) ability to operate satisfactorily with regard to smoke over a range of load much wider than is commonly characteristic of spreader stokers; (3) avoidance of investment in dust collectors or additional induced-draft-fan capacity to serve collectors; (4) avoidance of the per ton of fuel cost of 4 kwhr for dust-collector draft loss and 5 kwhr for secondary-air fan power minimum requirement of spreader stokers; and (5) with proper selection and application of equipment, ability to burn practically all varieties of bituminous coal mined east of the Mississippi.

Safety

Improved Materials Handling Will Bring Greater Safety to Your Industry, by Jervis C. Webb, Mem. ASME, Jervis B. Webb Co., Detroit, Mich. 1952 ASME Annual Meeting paper No. **52—A-155** (mimeographed).

A WELL integrated material-handling system carried out and making use of the most up-to-date thinking on both mechanical and manual means of handling goods will definitely pay dividends in safety as well as in increased production and lower costs, according to this paper.

This paper discusses the four common divisions of material handling. They are: Transportation—moving materials from one machine or department to another; processing materials in places where there is heat, corrosive, or bad atmospheric conditions; storage handling—placing of materials for ease in coming in and out of storage; and the assembly or making function of material handling.

The backbreaking, lifting, and heaving which brings on the strains would be minimized if all loads were taken over by the overhead trolley conveyer, the belt conveyer, the crane, the fork truck, and the many other mechanical means of lifting and carrying.

A definite mechanized storage system, in addition to cutting costs, also has its safety aspects. A mechanized storage system, definite as to location, method, and pile, minimizes the chance of stray parts lying around to cause accidents.

Further, overhead trolley conveyers carrying parts and subassemblies to temporary storage up on the trusses of the buildings, guarded below by good screen guards, take the material up and out of the production area and completely relieves manpower of concerning itself with it from a safety aspect. The fork truck, by stacking uniformly, eliminates the human element which might come up with a perilous, tippy pile.

Safety benefits can also be gained by making use of mechanical equipment such as belt conveyers, chain conveyers, and automation devices in the assembly of the product. By mechanically feeding machine tools and mechanically removing the finished material, the operator is kept away from the cutting heads, the dropping die, and other accident-causing points.

The paper also discusses some safety features of conveyers and general safety rules to follow when using conveying equipment.

Railroads

Operating Record of the Westinghouse-Baldwin Gas-Turbine Locomotive, by Charles Kerr, Jr., Mem. ASME, and T. L. Weybrew, Westinghouse Electric Corporation, East Pittsburgh, Pa., and T. J. Putz, Mem. ASME, Westinghouse Electric Corp., So. Philadelphia, Pa. 1952 ASME Annual Meeting paper No. 52—A-153 (mimeographed).

THE Westinghouse-Baldwin experimental gas-turbine locomotive has been operated on six railroads. This paper presents a record of this operation and summarizes the major problems encountered with the apparatus.

This locomotive is the first gas-turbine passenger unit to be operated in the United States. It is an eight-axle, single-unit locomotive, weighing 247 tons, powered by two 2000-hp gas turbines with an electric transmission. The principal weights, dimensions, and ratings of the locomotive are as follows: Horsepower, 4000; over-all length, 77 ft 10 in.; width over cab, 10 ft 2½ in.; maximum height, 15 ft; total wheel base, 62 ft 9 in.; rigid wheel base, 9 ft 0 in.; wheel arrangement, B-B-B-B; maximum tractive effort, 115,000 lb; continuous tractive effort, 52,800 lb; maximum speed, 100 mph; total weight loaded, 494,000 lb; fuel capacity, 4000 gal, and water capacity, 2300 gal.

The locomotive has been operated to learn the problems which might be encountered with this type of locomotive in railroad service, and to determine the necessary modifications to the original design. No attempt has been made to establish outstanding service records such as high daily mileages or long continuous runs.

It was first run on the Union Railroad for a period of about four weeks in May, 1950. This operation was in the nature of a shakedown test to make certain that all parts functioned as intended.

In June, 1950, the locomotive was moved to the Bessemer & Lake Erie handling freight trains between Greenville and North Bessemer, Pa., a round-trip distance of 200 miles. This service was discontinued after 20 days due to failure of turbine blading on one power plant.

Operation on these two roads was made with diesel fuel. While the locomotive was out of service to renew the turbine blading, modifications to handle heavy oils were made. Prior to a return to service, extensive standstill load tests with various grades of residual fuels were conducted during the remainder of 1950.

Road service was resumed in March, 1951, with a scheduled operation of six weeks on the Pittsburgh & Lake Erie between Pittsburgh and Youngstown. In this period, freight trains up to 5000 tons, and passenger trains up to seven cars were hauled. This experience indicated that further changes were required, particularly in the fuel handling, filtering, control, and burning apparatus.

In February, 1952, a considerably modified locomotive entered service on the Pennsylvania Railroad for a period of six weeks, hauling scheduled mail and express trains between Harrisburg and Altoona. The locomotive operated extremely well in this service, completing its assignment on the Pennsylvania by meeting 93 per cent of its scheduled runs without a single train detention. Mail and express trains of 26 to 29 cars were hauled on a schedule equivalent to those of fast passenger trains.

After completion of this assignment, the locomotive was moved to St. Louis, hauling revenue trains en route, where it was delivered to the Missouri-Kansas-Texas Railroad for passenger operation between Denison, Texas, and Parsons, Kan., handling the Katy Flyer northbound and the Bluebonnet southbound.

After completion of its scheduled assignment on the Missouri-Kansas-Texas, the turbines were opened for inspection. When the turbines were reassembled, the locomotive was placed in operation on the Chicago & North Western, making a daily round trip of 423 miles between Chicago and Elroy, Wis., hauling the Duluth-Superior Limited westbound and the Victory eastbound.

Management

The Executive's Responsibility to Stimulate Research and Product Development, by W. F. Rockwell, Jr., Mem. ASME, Rockwell Manufacturing Company, Pittsburgh, Pa. 1953 Management Conference paper No. 53—MGT-1 (mimeographed).

THIS paper describes the problems of an executive in stimulating research and product development. These problems are concerned with providing the proper climate for research, determining areas of desirable research, employee participation, and incentives for development of research thinking. It points out that the solution of these problems varies with the size of the corporation and the funds available. Product research is an essential part of doing business and the executive must stimulate a proper program to assure product success for appropriate return of stockholder funds.

In providing the proper climate for research the first job is to furnish good research direction, the paper states. Second, research men are entitled to adequate compensation, facilities, and good working conditions. According to the paper, management should be willing to supply "patient" money and not be too impatient for quick returns. The research director should be given a reasonably free hand.

Before starting any industrial project, two questions should be answered: (*a*) Is the state of knowledge in the particular field sufficiently developed to show that the project has a promise of success? (*b*) If results are obtained, does it seem likely that they can profitably be commercialized?

According to the paper, a research project should do one or more of the following: (*a*) Reduce cost of production, (*b*) reduce operating cost to the user, (*c*) increase the utility of the product, (*d*) increase its sales appeal, (*e*) produce new business, and (*f*) determine technical information contributory to some other project.

Integrating the Engineer Into the Engineering Organization, by John D. Whitmore, Airborne Instruments Laboratory, Mineola, N. Y. 1953 ASME Management Conference paper No. 53—MGT-2 (mimeographed).

ACCORDING to this paper, the task of integration is actually the task of accomplishing good human-relations practices.

There are many things which an engineer must know and several attitudes which must be accepted if he is to play a satisfactory part in an organization. He must (1) Develop an understanding of the fundamentals of business administration; (2) know the objectives of the firm for which he is working; (3) be familiar with the techniques and problems of selling the ideas, things, or services of his firm; (4) gain a working knowledge of the techniques of finance as applied to his business in particular, and the industry in which he is specializing; and (5) he must identify human-behavior patterns and understand why people behave as they do.

The paper concludes that not every public-relations man can be an engineer but every engineer can be a good public-relations man. Through good public-relations practices you can successfully integrate the engineer into the engineering organization.

Progress Control of Engineering Projects, by C. C. Winston, Ernst & Ernst, New York, N. Y. 1953 ASME Management Conference paper No. **53—MGT-3** (mimeographed).

THE steps to be taken to assure effective progress control of engineering projects are discussed. These steps include the following: (*a*) Organize on a group basis, (*b*) formalize the initiation of every project, (*c*) describe the project fully and estimate the engineering time before the project is assigned, (*d*) establish start dates in light of capacity and completion dates required, (*e*) reserve future capacity for all approved projects, (*f*) follow progress weekly, and (*g*) report progress and changes in time objectives monthly.

Initiation of all projects should be formalized through the use of a "request for engineering" which should include provision for the following information: Date and assigned project number, description of engineering study desired, budget date, desired end product, desired time objectives, preliminary estimate of engineering time, proposed project schedule, and space for approvals and tentative start dates.

Control of projects in terms of completing them at predetermined dates can never be achieved unless work is started on the project in time to allow completion in an orderly manner. Two considerations are involved: When should work start and do you have future design capacity available?

Actual assignment of engineers to projects should be done at the group supervisor level, the paper states. Control of progress should also be maintained at this same level. A workable method for controlling this assignment and follow-up is to provide a Taylor Board type of wall file. Once each week the supervisor and the engineer should meet to discuss and record progress on the projects.

Intangible Factors in Engineering Management by C. A. Butler, Jr., Mem. ASME, Diamond Alkali Company, Painesville, Ohio. 1953 ASME Management Conference paper No. **53—MGT-4** (mimeographed).

ENGINEERING management has a responsibility to the men in that department to manage engineering activities in a way that will merit the high regard of top management and others, the paper states. Among the many things necessary to fulfill this responsibility are the following:

1 Operate the department so that it can provide any required type of service promptly and economically.

2 Insist that engineering economics be practiced in all phases of design.

3 Keep lines of communication open so that engineers may develop a broader understanding of the other fellow's problems.

4 Help those who show a real liking for managing to develop latent managerial ability.

5 Relieve those in responsible charge of engineering and those who prefer strictly technical work from as much administrative detail as possible.

6 See that administrative details are given as careful attention as engineering details.

It is not particularly difficult to apply these things to the management of an engineering department, the paper states. It may be necessary, however, to make some changes from the old style of highly departmentalized department.

Half the job is done when not only those managing the engineering department, but others in the department realize these factors exist and resolve to do something about it.

Extending Engineering Skills With Large-Scale Digital Computers, by Allen Keller, Mem. ASME, General Electric Company, Lynn, Mass. 1953 Management Conference paper No. **53—MGT-5** (mimeographed).

MANY papers have been written on the use of high-speed, high-capacity computing machines for solving abstruse scientific and engineering problems. Much less has been written on the use of such machines for solving day-to-day repetitive engineering problems. This paper points out that a field exists for the use of large-scale computers in the solution of problems involving little but arithmetic and curve reading, and attempts to show how a typical engineering problem may be solved by a computer.

The paper is concerned with the large-scale computer of the "giant-brain" type in which all instructions as well as data are stored internally. It illustrates how a complicated problem such as the calculation of a turbine heat balance may be organized for automatic computation.

Some of the large variety of engineering problems which a large-scale computer could be used to solve include various kinds of stress and vibration problems, theoretical nozzle and bucket-design studies for turbines and compressors, power-plant-cycle studies, and many others.

ASME Transactions for April, 1953

THE April, 1953, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

The Piston Gage as a Precise Pressure-Measuring Instrument, by D. P. Johnson and D. H. Newhall. (52—HRD-2)

A High-Pressure Wire Gage Using Gold-Chrome Wire, by H. E. Darling and D. H. Newhall. (52—HRD-1)

An Application of High Pressure in Geophysics: Experimental Rock Deformation, by John Handin.

Techniques and Equipment for Generation of Dynamic High Pressure, by E. J. Mickevicz. (52—HRD-6)

A Sensitive Pressure Controller for High-Pressure Service, by P. L. Golden and A. F. Headrick. (52—HRD-4)

High-Pressure Research in Chemical Engineering Department of Yale University, by B. F. Dodge.

Influence of Residual Stress on Behavior of Thick-Wall Closed-End Cylinders, by J. H. Faupel and A. H. Furbeck. (52—HRD-9)

Rupture-Disk Design Evaluation and Bursting Tests, by G. R. Prescott. (52—HRD-8)

Design and Application of Controlled-Volume Pumps for High Pressure in the Range of 10,000 to 30,000 Psi, by D. H. Jones. (52—HRD-3)

Seals to Minimize Leakage at High Pressure, by B. A. Niemeier. (52—HRD-11)

Static-Dynamic Load Machine for High Pressure, by E. T. Fleischhauer and E. G. Dorsey, Jr. (52—HRD-10)

Local Coefficients of Mass Transfer by Evaporation of Water Into an Air Jet, by Maurice Spielman and Max Jakob. (52—SA-1)

Design and Development of a Broad-Range, High-Efficiency Centrifugal Compressor for a Small Gas-Turbine-Compressor Unit, by Ivan E. Speer. (52—SA-14)

Some Investigations With Wet Compression, by J. T. Hamrick and W. L. Beede. (52—SA-15)

Transient and Steady-State Heat Transfer in Irradiated Citrus Fruit, by H. F. Poppendiek.

Operation of Sunbury Steam-Electric Station Using Pulverized-Anthracite Fuel, by T. B. Richards. (52—F-3)

Cyclone Dust Collectors for Boilers, by A. J. ter Linden. (52—FU-1)

Mechanical Design in Oil-Shale Retorting Plants, by L. H. Brakel. (52—PET-10)

Engineering Features of the Union Oil-Shale Retort, by H. C. Reed and Clyde Berg. (52—PET-2)

Low-Temperature Insulation for Refinery Service, by W. L. Martin. (52—PET-12)

Full-Scale Fatigue Testing of Compressor Cylinders, by T. O. Kuivinen. (52—PET-22)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Oil Supply to Sleeve Bearings

COMMENT BY R. ARNOLD[1]

Those of us engaged in the business of designing and manufacturing sleeve bearings appreciate greatly the practical lubrication information given in the paper.[2]

Until the last few years, very little work has been reported along these lines, yet field surveys, in combination with laboratory tests, have demonstrated that some 60 per cent of automotive-engine overhaul is required because of wear alone, and an additional 20 per cent because of a combination of wear and deposits.

Several years ago we undertook a study of the causes of excessive wear, attempting to use the Underwood type of bearing test machine with which we had had considerable experience. We soon discovered that the results were inconsistent, that the oil pump and other parts showed more wear than the bearings, and that between tests it was all but impossible to remove all traces of the abrasive we were using. More recently we made another attempt, this time using full-scale engines. Here we found difficulty in controlling the rate of wear and in duplicating test results.

While studies of engine wear have been made in dust tunnels under controlled conditions, perhaps the best approach from a bearing standpoint is a special machine, or an adaptation of a standard machine, such as described in the paper. By this means, the contributing factors can be controlled independently and their effects recognized to better advantage.

It is generally agreed that for satisfactory operation, the size of solids in the oil should not exceed the minimum film thickness. Over the years we have made a number of theoretical studies on the thickness of oil films, particularly in automotive and truck applications. These data indicate that for the average-size shaft, the minimum oil film should be 100–125 microinches, or approximately 3 microns. Thus the importance of filtering hard particles in the range of 5–15 microns becomes evident.

Will the author explain what means were used to measure various dirt particles; and what is the effect of the shape of the particles, rather than their size?

COMMENT BY H. J. DAWE[3]

We agree with the author that solid inclusions in the oils supplied to sleeve bearings may affect their operation. However, the test data he has obtained under highly idealized conditions may not be too indicative of what would be observed under actual operating conditions. In any case it should not be concluded or implied that his data apply to systems other than sleeve bearings operating under full fluid-film conditions.

It seems to us that his equipment design is such as to mask the effect of inclusions. Under hydrodynamic flow the shaft is supported by an oil film of appreciable thickness. Only particles larger than this thickness would be expected to produce marked effects. Graphite or molybdenum-sulphide particles which he designated "30 micron" or "39 micron" have that diameter, but have a thickness of only a few microns. The only particles studied which exceed the film thickness are those of corundum. In that case, the expected bearing wear and high friction were observed. The finer abrasive, rouge, has substantially no effect. Neither do the lubricating solids, graphite or molybdenum sulphide.

In situations where the oil film is deficient, or where boundary conditions are present, even intermittently, the effect of inclusions becomes more pronounced. Then even rouge would show its abrasive character, and the lubricating nature of graphite or molybdenum sulphide would come into play.

To obtain maximum benefit from graphite, it should be present on the bearing in an extremely thin, adherent, lubricating coating—the so-called "graphoid" layer. Formation of this layer is aided by several factors: (1) Fine particle size, as present in colloidal graphite; (2) long-continued operation under full fluid-film conditions; (3) operation at least part of the time under boundary conditions. Similar factors would apply to molybdenum sulphide. These conditions are not met in the author's tests. The slight hindrance to oil flow observed with higher graphite concentrations is, as stated, due to collection of particles in oil grooves. This factor is not present with colloidal graphite.

Considering the limited scope of this investigation, we feel the conclusions listed should be strictly qualified. The hurried reader, scanning the journal, could well read only the conclusions, and read into them much more than is stated or even intended. The wide use of colloidal graphite in oil certainly is inconsistent with the statement that it "will produce no improvement in the bearing operation."

COMMENT BY B. P. ROBERTSON[4]

While this paper provides basic information of considerable interest, it is especially worth while in sorting out some practical facts regarding bearing operation, filter performance, and lubrication systems in general. It is timely because of the frequent discussions regarding filtration and performance of crankcase oils that appear dirty as a result of the increasing use of detergents.

The demonstrated lack of relationship between oil appearance, and bearing wear and friction loss is of special interest to those concerned with practical lubrication. These further data regarding the effect of concentration, size, and nature of particle inclusions in oil provide specific information upon which decisions regarding the lubrication system can be based.

The author points out the marked oil discoloration that is possible with small concentrations of finely divided material such as graphite. Since detergent-type lubricants tend to disperse deposits into extremely small particles, it appears possible for them to be severely darkened by total amounts of contaminants smaller than those concentrations found

[1] Cleveland, Ohio.

[2] "Effects of Solid Inclusions in Sleeve-Bearing Oil Supply," by H. G. Rylander, MECHANICAL ENGINEERING, vol. 74, December, 1952, pp. 963–966.

[3] Technical Director, Acheson Colloids Company, Port Huron, Mich.

[4] Section Head, Fuels and Lubricants, Sales Technical Service Division, Humble Oil & Refining Company, Houston, Tex. Mem. ASME.

necessary to affect oil flow. Then, with proper filtration that would remove abrasive particles greater in size than oil-film thickness, good lubrication, proper cooling, and minimum wear would be expected.

While such assumptions may be drawn on the basis of this paper, it would be of interest to observe bearing performance further with crankcase-sludge-type contaminants and high detergency lubricants of the MIL-O-2104, Supplement 2 class. Such further details regarding the effect of particle concentration upon oil-flow characteristic should be of interest to those concerned with the lubrication of internal-combustion engines depending upon high detergency oils for satisfactory piston-and-valve-assembly performance.

The comparison of results obtained with abrasive and nonabrasive-type inclusions is interesting. Although the wear encounteree with abrasive inclusions was eliminated when solid-type lubricants were present, the improvement was no greater than that experienced with the straight mineral oil. This appears in accord with any analysis based upon the mechanics of the lubrication process within the range of operation covered during the test program. The bearing pressures possible with the soft bearing metals are simply below those where substantial improvement in performance would be expected. This is especially true where the bearing is designed to operate under fluid-film conditions.

It is in the extreme-pressure region that the benefits of solid lubricants can become apparent. As an example, a series of tests are recalled where the lubrication of steel surfaces under unit contact pressures in the region of 100,000–800,000 psi and with very low shear rates was investigated. Considerable improvement in shear properties was experienced with molybdenum disulphide and colloidal graphite over that possible with any mineral oil alone.

The author is certainly to be commended for his informative, concise treatment of an interesting program. Encouragement should be extended for other such investigations that will increase and organize further the worth-while knowledge in this practical field.

COMMENT BY E. A. SMITH[5]

It is difficult to appreciate what the author is seeking to show with his experiments. The lubrication of a journal bearing presents the smallest of industry's problems. Reciprocating faces, heavily and impulsively loaded, bearings, and slow-moving plane surfaces are those in which reinforcement of the oil may be required by such additives as graphite or molybdenum disulphide.

The over-all effect produced by the author in bringing together such lubricant solids as graphite and molysulphide, and such abrasives as rouge and corundum, is one of confusion. Altogether, the conclusions are unfortunate in the confusion and contradictory thoughts which they are calculated to raise in the minds of engineers.

The coefficient of friction of pure graphite or high-grade molybdenum disulphide lies in the vicinity of 0.05–0.10. This is comparable with the coefficient which could be expected from a boundary film of oil in a journal bearing. The coefficient of friction of corundum could correspond to the yield value of the metal on which it lies, and it is doubtful whether one should regard an abrasive of this kind in the same way as a lubricating solid. Just as one could not quote a coefficient of friction for a hard abrasive, so is it questionable to consider ZN/P curves for such a material.

If the coefficient of friction of a bearing is unaltered by the presence of a solid lubricant, it is evident that full fluid conditions of lubrication obtain. Under boundary conditions, friction values for plain oil would rise to greater than 0.05, when the characteristic friction of the solid lubricant would become evident. Once the boundary state is reached, anything can happen with plain oil lubrication, so that the protective value of graphite and molysulphide assumes importance. In fact, it is the way in which equipment is protected from seizure by graphite that has given this solid lubricant such a wide appeal to industry and associates. But this latter work also can explain why there can be a correlation between friction and wear in the presence of solid lubricants such as graphite and molybdenum disulphide. The author has referred to the fact that there was no observable wear of the bearing lubricated with the aid of graphite and molybdenum disulphide. This is in conformity with what is known of the frictional characteristics of these two valuable lubricant additives.

It is a pity that the author did not give due regard to what has been published on the lubricating value of these solid lubricants. Furthermore, the implications of his paper in this respect run counterwise to the international popularity of the lubricants.

[5] Technical Manager, Acheson Colloids Limited, London, England.

COMMENT BY D. F. WILCOCK[6]

The results presented in this paper are of considerable interest in that they give a qualitative picture of the effectiveness of graphite and molybdenum disulphide when used as a suspension in oil.

It would be helpful if the author had shown a drawing of the construction of the test bearing portion of this test machine so that details of the means of applying load and measuring the bearing torque would be available to the reader. Another omission seems to have been the specification of the clearance of the bearings used in these tests.

The Sommerfeld number might have been a better variable to use in comparing tests on different bearings rather than ZN/P, since the Sommerfeld number would serve to correct for variations in clearance. The author has plotted fc/d versus ZN/P rather than the conventional plot of fd/c versus $(d/c)^2\ ZN/P$. Since both of the latter co-ordinates are complex functions of the eccentricity of the bearing, dividing each by $(d/c)^2$ does not leave one with a valid comparison between results on different bearings. It also should be pointed out that the theoretical solution of Reynolds equation referred to is for the infinite bearing. It might be more appropriate to compare results with the calculations for bearings of finite length such as those given by Cameron and Wood.[7] A table of data would be helpful to the reader in carrying out other interpretations of these results.

AUTHOR'S CLOSURE

The scope of this paper was arbitrarily limited to babbitt bearings and only a few particles because of the vast number of possibilities for extension of the program. Where it is pointed out that no significant improvement is possible with babbitt and steel using these solids as a lubricant, it has been demonstrated in later tests that a very remarkable improvement may be obtained with certain bearing materials. This report is now being completed for publication.

Mr. Dawe's comments as to the size of particles of graphite and molybdenum-sulphide were demonstrated in our test program. It was found that our results were not altered by changing the particle size, as the soft particles of a material like graphite were easily broken down to smaller sizes in the pump and bearings.

The particles used in these tests were

[6] Bearings and Chemistry Section, Thomson Laboratory, General Electric Company, West Lynn, Mass. Mem. ASME.

[7] "The Full Journal Bearing," by A. Cameron and Mrs. W. L. Wood, Proceedings of The Institution of Mechanical Engineers, vol. 161, 1949, pp. 59–64.

sized in two ways. First, the particles were purchased from reliable companies as sized particles. Second, a measurement of a sample of particles was made by using a filar micrometer microscope. This direct measurement was made by preparing a slide of a few hundred particles and visually selecting the larger particles for measurement. The accuracy of our measurement was in the order of one micron. Substantial agreement was obtained between measured sizes and purchased size. Measured maximum particle sizes were slightly larger than purchased specifications. Considerably more accurate measurements could have been made by photographing through microscopes with higher magnification, but this was not considered of sufficient value to warrant the extra difficulty.

The effect of shape of particles was not determined; however, it has been demonstrated that the sharp-cornered abrasives cause more rapid wear than round dull particles of the same hardness. Wear on the particles was not measured, nor were the particles replaced with new sharp ones after a certain period of time. All cutting edges dull with use; therefore these abrasive particles must have a limited period of abrasive use.

It is possible that improvement in bearing friction could be obtained in the vicinity of friction coefficients from 0.05 to 0.10 as stated by A. E. Smith. This range could not be explored because of temperature limitations of the bearing material when operating in the test-speed range. Operation under partial lubrication produced rapid temperature increases ending in complete bearing seizure. Starting or stopping conditions would be improved by coefficients of friction between 0.05 to 0.10.

Plots of $\frac{ZN}{P}$ were used instead of the Sommerfeld number because of the wide use of this term. There seemed to be little benefit in the use of the Sommerfeld number if the attitude or the oil-film angle were not completely determined for all operating conditions. Film angle is difficult to calculate accurately with grooved bearings and a variable oil inlet pressure.

The comments, additional information provided, and the requests for information have been very helpful in the presentation of this paper.

H. G. Rylander.[8]

[8] Assistant Professor of Mechanical Engineering, The University of Texas, Austin, Texas. Jun. ASME.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Servomechanism

SERVOMECHANISM ANALYSIS. By George J. Thaler and Robert G. Brown. McGraw-Hill Book Co., Inc., Electrical and Electronic Engineering Series, New York, N. Y.; Toronto, Ont., Can.; London, England, 1953. Cloth, 5½ × 9 in., figs., problems, tables, appendixes, bibliography, index, xii and 414 pp., $7.50.

REVIEWED BY RUFUS OLDENBURGER[1]

SINCE the appearance of the 1944 volume by R. C. Oldenbourg and H. Sartorius in Germany on the subject, there has been a deluge of books both here and abroad devoted to the frequency response approach in the design of that large body of automatic controls that can be classed as servomechanisms. With the success this approach has had in the development of search radar, guided missiles, and other military applications, frequency-response techniques are now invading industry generally.

From frequency-response runs made on the control and the system to be controlled, the mathematically untrained technician with a great deal of experience with frequency-response curves can often tell whether or not the control will operate satisfactorily when placed on the system to be controlled. Even though he does not understand the tremendous body of mathematics underlying what he does he can at least make a start on the scientific design of automatic controls.

The important position frequency response holds today is due in part to a general lack of familiarity or experience with simple algebraic methods, such as synthetic division, and to the geometric mindedness, rather than algebraic, of many engineers who prefer drawing a curve to manipulating an algebraic formula. The present tremendous interest in and extensive use of frequency response methods makes this book under review particularly valuable. In it the reader is introduced to Laplace transforms immediately. The Nyquist stability condition, polar plots, Nichols charts, gain adjustment, and compensation are then discussed in a particularly lucid manner. The theory is illustrated by well-chosen examples. The authors have avoided a cluttered text by placing detailed descriptions of control components in a series of appendixes. In these appendixes the reader will find careful descriptions of magnetic amplifiers, amplidynes, synchro systems, and other important control components in current use.

The book was written too early to include the results of the considerable recent activity in extending the transfer function concept to nonlinear systems, except for a very fine exposition of the pioneer work of Ralph Kochenburger on relay servomechanisms. The work of E. C. Johnson of the United States, J. Loeb of France, and L. C. Goldfarb of Russia, and others on "describing functions" is greatly expanding the range of application of the frequency response approach to areas where the usual algebraic methods fail. Dead band, hysteresis, saturation, and variable damping are examples.

It is unfortunate that the authors, as well as previous writers on the subject, attribute the rules for automatic-control design to experience when these rules can be justified, where they do hold, by mathematical theory that can be readily developed by a mathematician willing to devote some effort and time to this subject. It can be shown by statistical methods that in their performance characteristics linear systems are essentially of low order. It is then only necessary to prove that the design rules apply to systems of low order. This has been done for the simplest systems, but the work has not been carried far enough to convince the workers in the field.

The book closes with an exposition of the Evans root locus method for finding the roots of the characteristic equation. The inclusion of this method alone makes the book a necessary component of the library of the control scientist and engineer. In one illustration of the Evans approach, the authors solve a simple problem by classical methods, and then by the root locus technique. Although the problem is a

[1] Research Mathematician, Woodward Governor Company, Rockford, Ill. Mem. ASME.

very good one for teaching the root-locus method, it by no means shows the advantages of this method over classical solutions. The authors say that "the reduction in labor is apparent" when actually the contrary is true of the particular illustration used. It is an example of the tendency of engineers in this field to be swept away by their enthusiasm for techniques with which they are familiar.

The frequency response approach to automatic-control problems is the current fad. Like all fads it will eventually drop out of the limelight and assume its proper place among the powerful methods available to the designer of automatic controls. The authors are to be commended for their superb exposition of this important and rapidly changing field.

Dexter S. Kimball

I REMEMBER: an autobiography, with a foreword by R. E. Flanders. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Ont., Can.; London, England, 1953. Cloth, 5¼ × 8 in., plates, appendixes, index, xii and 259 pp. $4.

REVIEWED BY A. A. POTTER[2]

A DELIGHTFUL story about a great personality who was sensitive to his surroundings and to human reactions, told in an animated style so typical of this fine engineer and engineering teacher. He lived in a period of the most remarkable scientific and industrial progress in human history, and kept in close touch with the developments of his time and with many of the leaders who made them.

In the year of his birth, 1865, this country represented largely a handicraft society. His life paralleled the change of the United States of America from a people largely concerned with the production of raw materials into the greatest manufacturing nation in the world. In 1865 electricity was in its infancy; telephones, gas engines, steam turbines, radios, automobiles, aeroplanes, and many of the other creations of science, industry, and engineering, which are now taken for granted, were unknown.

In 1881, at the age of sixteen, he found employment as an apprentice in the Puget Mill Company machine shop. Seven years later he went to San Francisco to work as a lathe operator for the Union Iron Works, and as his work narrowed to routine, he decided to improve his education by entering Stanford University in 1893. He delayed his technical education largely because it was not available. His time, however, was not wasted, as when he entered college he was thoroughly familiar with machine construction as it was actually carried out, with all kinds of people in the machine industry, with their problems, background, and needs. Stanford in 1893 was in its very beginning, but had on its faculty unusual teachers, who stimulated Kimball's interest in education. In speaking of Stanford, he said: "There is a virile spirit in a new institution of learning which is often reduced or even lost with passing of years and a greatly enlarged student body."

Following his graduation from Stanford in 1896, he spent two more years with the Union Iron Works, one year in Montana, and entered upon his academic career in 1898 as a teacher of machine design at Cornell University. This he interrupted in 1901 to accept a position of works manager for the Stanley Electric Manufacturing Company at Pittsfield, Mass., but returned to Cornell in 1904, where he continued until his retirement in 1936, holding the position of Dean of the College of Engineering from 1920 to 1936.

Dean Kimball came into the academic world with a good background of manufacturing experience and ability to design and build machines. This enabled him to make distinctive contributions to engineering education through the introduction of superior courses in machine design and industrial management.

In addition to his contributions to engineering education and industry, Dean Kimball will be remembered for his inspiring leadership in the engineering profession and for his vital work with the War Production Board during the second World War.

Dean Kimball's sincerity, industry, native ability, broad interests, patriotism, and affection for people make his autobiography an inspiration to young people who are interested in engineering as a career, while affording to his many friends a lasting record of a great engineer and exemplary citizen, whose life was full of distinct achievements and lasting values.

[2] Dean of Engineering, Purdue University, Lafayette, Ind.; President, Bituminous Coal Research, Inc. Past-president and Hon. Mem. ASME.

Books Received in Library

ASTM MANUAL OF ENGINE TEST METHODS FOR RATING FUELS. American Society for Testing Materials, Philadelphia, Pa., 1952. Bound, 6¼ × 9¼ in., 342 pp., charts, diagrams, illus., tables, $8. This manual presents in their latest approved form the five standard methods for rating motor, aviation, and diesel-engine fuels. Six detailed supplements are included which contain information on the best practices currently in use for laboratory facilities, installation of the engine test units, provisions for reference materials, and electrical, water, and air services, and the operation and maintenance of the units.

ADVANCED MATHEMATICS IN PHYSICS AND ENGINEERING. By Arthur Bronwell. McGraw-Hill Book Company, Inc., New York, N. Y., first edition, 1953. Bound, 6½ × 9¼ in., 475 pp., charts, diagrams, $6. Fundamental physical laws in many of the more important fields of physics and engineering are expressed in general form by mathematical formulations, forming a basis for the development of numerous applications. The text shows how these fundamental formulations simplify to special cases which often form the starting point in the solution of problems. The underlying unity in the methods of mathematical analysis in the various fields is emphasized. Emphasis is also placed on applications in dynamics rather than in statics: heat flow, fluid dynamics, electromagnetic theory, vibration in mechanical and electrical systems, and so on. Solutions are given of typical problems.

ANALYTIC MECHANICS. By Virgil Moring Faires and Sherman Daniel Chambers. The Macmillan Company, New York, N. Y., third edition, 1952. Bound, 6¼ × 9½ in., 540 pp., diagrams, illus., $6. This book follows, in general, the basic plan of organization of Chambers' "Mechanics of Engineering" but is a completely rewritten edition. The material has been so arranged that the student begins with elementary material on simple forces and works gradually through friction, moments, and so on, to the more advanced topics of balancing, impulse and momentum, and mechanical vibrations. Gyroscopic action and dimensional analysis are briefly treated in appendixes.

ESSENTIALS OF FLUID DYNAMICS. By Ludwig Prandtl. Hafner Publishing Company, New York, N. Y., 1952. Bound, 6 × 8¾ in., 452 pp., charts, diagrams, illus., $6. A translation of a recent German treatise on the flow of fluids, intended to provide a comprehensive and easily understandable account of

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

the subject, in which the mathematical treatment is held to a minimum. Major sections are as follows: equilibrium of liquids and gases; kinematics and the dynamics of frictionless fluids; the motion of viscous fluids, turbulence, and so on; flow with appreciable volume changes (dynamics of gases); miscellaneous topics (combined effects, special flow problems, and heat transfer in moving fluids). Many practical applications to hydraulics, aeronautics, and other subjects are included.

FLUAGE PLASTICITÉ PRÉCONTRAINTE. By F. Levi and G. Pizzetti. Dunod, Paris, France, 1951. Bound, $6^1/_2 \times 9^3/_4$ in., 463 pp., charts, diagrams, tables, graphs, 3900 fr. An extensive analysis of the phenomenon of creep in solid bodies caused by long-term loading below the elastic limit of rapid plastic deformation under a load exceeding the elastic limit, and of prestressed concrete construction. Both theory and mechanical and structural applications are dealt with. Approximately half the book is devoted to prestressed concrete with detailed design data on beams. The treatment is based on the earlier work of the Italian scientist, Colonetti.

"FIRST BOOK" ON FIRE SAFETY IN THE ATOMIC AGE. By Horatio Bond. National Fire Protection Association, Boston, Mass., 1952. Bound, $5^1/_2 \times 8$ in., 72 pp., charts, illus., $3. Essentially a discussion of the modifications and additions to peacetime fire safety measures which will be necessary in attempting to achieve effective control of atom-bomb fires. The author deals briefly but clearly with primary and secondary fire effects, with proper construction and location of buildings, and with both passive and active prefighting methods. A considerable bibliography is included.

HANDBOOK OF CHEMISTRY. Compiled and edited by Norbert Adolph Lange. Handbook Publishers, Inc., Sandusky, Ohio, eighth edition, 1952. Bound, $5^1/_2 \times 8$ in., 1998 pp., tables, charts, $7. This standard handbook is a comprehensive reference volume for all who require ready access to chemical and physical data used in laboratory work and manufacturing. In this eighth edition 26 tables have been extended or completely rewritten, and six new tables have been added on such varied topics as ionization potentials of elements, classification of clay minerals, titrimetric indicators, and molar equivalents. In the general revision necessary corrections, changes, and additions have been made, and some tables have been omitted to make room for more useful material. As before, Beilstein references are given in the extensive table of physical constants of organic compounds.

HIGH SPEED PHOTOGRAPHY. By George A. Jones. John Wiley & Sons, Inc., New York, N. Y., 1952. Bound, $5^1/_2 \times 8^1/_2$ in., 311 pp., diagrams, illus., $6.50. A comprehensive presentation of broad fundamental theory, practical operative techniques, and technical applications. Detailed descriptions are given of the light-generating and the photographic equipment for both still and motion pictures. A wide range of scientific, industrial, and commercial applications is covered, with the special requirements and limitations in each case. The book is well-illustrated and contains extensive lists of references.

HOW TO CONTROL PRODUCTION COSTS. By Phil Carroll. McGraw-Hill Book Company, Inc., New York, N. Y., first edition, 1953. Bound, $6^1/_4 \times 9^1/_4$ in., 272 pp., charts, tables, $5. A step-by-step explanation of the factors involved in accurate production-cost control. The effect of each factor is discussed with relation to the actual part played in the overall setup. Examples are given of both incorrect and correct application, with a realistic depiction of results in each case. The author covers the whole range of industrial operation: sales forecasts; engineering and manufacturing processes; overhead allocation and other accounting details; cost standardization; incentives and other management aspects.

MECHANICS. By Arnold Sommerfield. Translated from the fourth German edition by Martin O. Stern. Academic Press Inc., New York, N. Y., 1952. Bound, $6^1/_4 \times 9^1/_4$ in., 289 pp., charts, $6.50. This first volume of six, which will together constitute a complete translation of the author's course of lectures on theoretical physics in Munich, covers basic principles of mechanics such as momentum, energy, and least action. Beginning with Newton's fundamental analysis, the mechanics of a particle and the mechanics of systems are first studied. Other chapters include a discussion of pendulums, rigid bodies, relative motion, and Hamilton's theory. Physical problems rather than mathematical analysis are stressed, and many concrete applications in astronomy, physics, and engineering are pointed out.

PETROLEUM PRODUCTION ENGINEERING. Oil Field Exploitation. By Lester Charles Uren. McGraw-Hill Book Company, Inc., New York, N. Y., third edition, 1953. Bound, $6^1/_4 \times 9^1/_4$ in., 807 pp., charts, diagrams, illus., tables, $10. A detailed survey of the technology of oil production beginning with the completion of the field-development phase and ending with the transportation of the products to market. It covers processes, methods, and equipment and the physical principles that control the recovery of petroleum from its reservoir rocks. This is one volume of a series of three, of which the other two cover oil-field development and production economics. The selected lists of references accompanying each chapter have been revised along with the text to bring the whole book up to date.

POWER PLANTS FOR AIRCRAFT. By Joseph Liston. McGraw-Hill Book Company, Inc., New York, N. Y., 1953. Bound, $6^1/_4 \times 9^1/_4$ in., 577 pp., charts, diagrams, illus., tables, $8.50. A textbook for the undergraduate student in aeronautical and mechanical engineering, this volume gives the reader a concise, technical insight into the basic principles of all types of aircraft power plants. Included in the presentation are accurate and comprehensive comparisons of the many types of jet and reciprocating power plants, a fundamental analysis of the theoretical power-plant cycles, a comparison of actual engine performance with the theoretical cycles, and a discussion of some of the practical problems met in operation and testing. Many diagrams and charts illustrate and amplify the text.

PRECISION MEASUREMENT IN THE METAL WORKING INDUSTRY. Prepared by the Department of Education of International Business Machines Corporation. Syracuse University Press, Syracuse, N. Y., revised, 1952. Bound, $7^1/_4 \times 10^1/_2$ in., 365 pp., diagrams, illus., tables, $6.50. This manual was prepared for use in the factory-training program of the International Business Machines Corporation. Opening with a general statement on measurement, successive chapters are devoted to line-graduated instruments, precision-gage blocks, plug, ring and snap gages, thread gages, dial gages and test indicators, micrometers and verniers, surface plates and accessories, angle-measuring instruments, comparators, optical instruments and surface-finish measurement, measuring machines, hardness testers, and nondestructive testing methods. The construction and uses of these devices are explained simply and are profusely illustrated by photographs and detailed drawings.

PRINCIPLES OF PHYSICAL METALLURGY. By Gilbert E. Doan. McGraw-Hill Book Company, Inc., New York, N. Y., third edition, 1953. Bound, $6^1/_4 \times 9^1/_4$ in., 331 pp., charts, diagrams, illus., tables, $5.50. This textbook aims to supply a unified account of present-day knowledge of metals and alloys, with special reference to their behavior when operated upon in manufacturing. The physics of metals, metallography, and metal technology are successively discussed; attention is focused upon the principles of the behavior of metals as a whole, not of individual metals or alloys. Among the over-all revision, chapter 3 on the mechanical properties of metals has been rewritten from the viewpoint of explanation in terms of electrons and atoms.

SCALE MODELS IN HYDRAULIC ENGINEERING. By J. Allen. Longmans, Green and Company, Inc., New York, N. Y., second edition, 1952. Bound, $5^3/_4 \times 8^3/_4$ in., 415 pp., charts, diagrams, illus., tables, $8. The author's aim is to present the principles which underlie the technique of various hydraulic model experiments, and to provide a critical survey of the present situation, pointing out limitations as well as advantages. The emphasis is on river problems and these are dealt with in great detail with full reference to existing models, mainly British. Special aspects such as the effect of salinity on silt deposition and the construction of tide-generating mechanisms are treated. Extensive references to the technical literature are made throughout the book. Some indication is given as to the scope for further systematic study, particularly of "scale-effects."

SELECTION OF TABLES FOR USE IN CALCULATIONS OF COMPRESSIBLE AIRFLOW. Prepared on behalf of the Aeronautical Research Council by the Compressible Flow Tables Panel, L. Rosenhead (chairman). Oxford University Press, New York, N. Y., 1952. Bound, $8^1/_2 \times 10^1/_2$ in., 143 pp., tables, $8. An authoritative selection of important tables having wide application. They are classified into the following groups: isentropic flow tables; characteristic tables; shock tables; tables for the reduction of pressure ratios; tables of powers of x and $(1 - x^2)$; a section of miscellaneous tables. Special attention was paid to the accuracy of new calculations, to the checking of existing tables, and to careful proofreading. Functions more suitable for reproduction in the form of graphs or charts are not included but will be presented in a volume to be devoted to graphs only.

SYMPOSIUM ON DETERMINATION OF ELASTIC CONSTANTS. American Society for Testing Materials, Philadelphia, Pa. (Special Technical Publication No. 129) 1952. Paper, 6×9 in., 100 pp., diagrams, illus., tables, $2. In addition to a report on the results of a questionnaire concerning methods now in use and further constants required, this symposium includes the following papers: influence of temperature on elastic constants of steels; methods for determining elastic constants of nonmetallic materials; dynamic methods for determining elastic constants and their temperature variation in metals; evaluation of several static and dynamic methods for determining elastic moduli.

ASME NEWS

With Notes on the Engineering Profession

ASME Goes West for Interest-Packed 1953 Semi-Annual Meeting

Headquarters—New, Air-Conditioned Hotel Statler, Los Angeles, Calif., June 28–July 2, 1953

ARMED with one of the most interesting, carefully planned technical programs of many years, The American Society of Mechanical Engineers is going deep into the land of superlatives to hold its 1953 Semi-Annual Meeting at the newly completed, air-conditioned Hotel Statler, Los Angeles, Calif., June 28–July 2, 1953. In the face of the challenge that present-day world conditions present to the engineering profession—will it be peace, or will it be war—the Southern California Section and the professional divisions of the Society have banded together to give a forward-looking and tremendously interesting program, evaluating the present without forgetting how "Well Done" was earned in the past.

Heat Transfer and Fluid Mechanics Institute

The Heat Transfer and Fluid Mechanics Institute will cosponsor the ASME Heat Transfer sessions at the Hotel Statler, Monday, June 29. The program arranged by the HTFMI will be held on Tuesday morning and afternoon; Wednesday morning, afternoon, and evening in Founders Hall on the campus of the University of Southern California, 3518 University Avenue, Los Angeles—a 15-minute taxi ride from the headquarters hotel. The remaining sessions of the HTFMI will be held Thursday morning and afternoon, July 2, at the Hotel Statler and will include participation at the Heat Transfer Luncheon.

There will be no registration fee for ASME Members attending these sessions, who have already registered for the Semi-Annual Meeting.

Technical Program

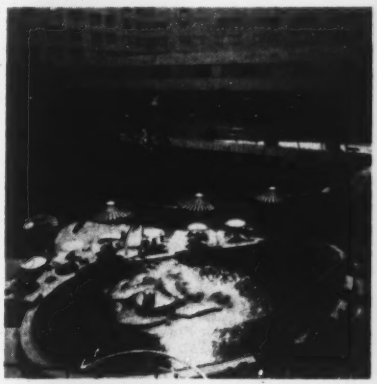
More than forty sessions are devoted to the technical program. Approximately 100 papers have been scheduled which will cover the following fields: power, management, heat transfer, applied mechanics, gas-turbine power, process industries, aviation, hydraulics, production engineering, petroleum, materials handling, machine design, boiler-feedwater studies, fuels, metals engineering, education, oil and gas power, industrial instrumentation, and lubrication. In addition, the American Rocket Society, an affiliate of ASME, will offer two sessions. There are also sessions scheduled to be held jointly with the Institute of the Aeronautical Sciences and the Society of Automotive Engineers.

Los Angeles—Fabulous City

Besides this diversified technical program, Los Angeles and its surrounding area will offer visitors a variety of topography, scenery, people, and industries. In Los Angeles county scenery and topography run from arid, sandy desert to lush gardens and orchards, to pine-studded mountains, to cool, surf-washed beaches.

Los Angeles is cosmopolitan, its atmosphere of Spain blending with a touch of the Orient, a whiff of Paris, and a dash of the Old West—all wrapped in modern American trimmings.

Commercially and economically, Los Angeles is as kaleidoscopic as it is in terrain and people, ranking as a national leader in manufacturing of all sorts. It is a center of airplane building, petroleum production, steelmaking, automobile assembly, giftware designing, rubber working, and countless other fields. The value added to products in manufacturing processes is now $2,885,000,000 a year.



NEW, AIR-CONDITIONED HOTEL STATLER, LOS ANGELES, SITE OF THE 1953 ASME SEMI-ANNUAL MEETING, JUNE 28–JULY 2

(The pool, *shown*, in Statler Gardens is nine ft deep at one end, five ft at the other. It is expected that the pool will be used for exhibition swimming and diving. Floating fountain, *center*, can be removed.)

Inspection Trips

Millions of dollars are being poured into industrial establishments, ranging from small plants to giant automobile factories and aircraft plants. To give some idea of its industrial scope, plant trips have been arranged to Lockheed Aircraft Corporation, Burbank; French Sardine Company, Terminal Island; Exchange Lemon Products Company, Corona; C. F. Braun Corporation, Alhambra; Lever Brothers Company, Bell; and Hyperion Treatment Plant, Playa del Rey.

Hotel Reservations

Members are urged to write for reservations early—be sure to mention the fact that you are planning to attend the 1953 ASME Semi-Annual Meeting in order to facilitate the processing of assignment of accommodations by the hotel staff. June 18 is the absolute deadline. Address requests for space to T. M. O'Hara, Front Office Manager, Hotel Statler, 930 Wilshire Boulevard, Los Angeles, Calif., or Teletype LA 985.

Schedule of Registration

Sunday, June 28	3:00 p.m. to 8:00 p.m.
Monday, June 29	8:00 a.m. to 8:00 p.m.
Tuesday, June 30	8:30 a.m. to 6:30 p.m.
Wednesday, July 1	8:30 a.m. to 3:00 p.m.
Thursday, July 2	8:30 a.m. to 3:00 p.m.

Headquarters' Hotel—Statler

Meeting Registration—Ballroom floor

Ladies' Headquarters—Roof Terrace, Ballroom floor.

Committees

The Southern California Section of ASME will be host for the meeting. C. M. Sandland is chairman and R. F. O'Mara, vice-chairman. Chairmen of the various committees in charge of arrangements for the Semi-Annual Meeting are: J. S. Newton, *Technical Events;* J. Richard Phares, *Printing and Signs;* R. M. Hatfield, *Hotel;* Alfred Dahlstrum, *Entertainment;* M. A. Wise, *Plant Trips;* W. Julian King, *Information and Registration;* Norman Lynn, *Publicity;* V. A. Peterson, *Reception;* Mrs. George W. Ehrhart and Mrs. V. A. Peterson, *Ladies Program;* and I. Earl Sage, *Finance.*

Tentative Program

Available preprints of *numbered* papers may be purchased from ASME Order Department, 29 West 39th Street, New York 18, N. Y. Please order by number as listed in program. The tentative program follows:

MONDAY, JUNE 29

8:00 a.m.

Registration

9:30 a.m.

Power (I)

Boiler-Cleaning Systems—Principles and Practices, by *Lyle B. Schueler,* Diamond Power Specialty Corp.

The Application of Additives to Fuel Oil and Their Use in Steam-Generating Units, by *J. B. McIlroy, E. J. Holler, Jr.,* The Babcock & Wilcox Co., and *Roderic B. Lee,* Florida Power Corp. (Paper No. 52—A-160)

Removal of Fireside Deposits Through Use of Mechanical Slag Blowers, by *J. A. Vanyo* and *S. F. Wallese,* Continental Foundry & Machine Co. (To be presented by *Delos E. Hibner, Jr.,* Continental Foundry and Machine Co.)

9:30 a.m.

Management (I)

Physical Control as Applied to Production Control, by *Joseph Druliner,* Norris Thermador Corp.

A Computational Technique for the Scheduling Problem, by *Melvin E. Salveson,* University of California

Cost Reduction Through Electronic Production Control, by *R. G. Canning,* University of California

Official Notice
ASME Business Meeting

THE Semi-Annual Business Meeting of the Members of The American Society of Mechanical Engineers will be held on Monday, June 29, 1953, at 4:30 p.m., Hotel Statler, Los Angeles, Calif., as part of the Semi-Annual Meeting of the Society.

The program is planned to include the announcement of the location of the 1954 Semi-Annual Meeting, election of the Nominating Committee for 1954, and to the consideration of constitutional changes in membership-grade names and qualifications.

This Business Meeting of the Members provides an opportunity for a free discussion of Society policies and procedures and all members are urged to attend.

Time to Join the Tours to and from Los Angeles

ASME Semi-Annual Meeting, June 28–July 2

PRECONVENTION tour including National Parks in the United States and Canada—16 days—$750.

Postconvention tour of Hawaii—20 days—$850, from New York, N. Y.

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There is still time to join either of these fine tours during the month of May. For full details and information address queries to: Ernest Hartford, ASME Headquarters, 29 West 39th Street, New York 18, N. Y.

9:30 a.m.

Heat Transfer (I)—Heat Transfer and Fluid Mechanics Institute (I)

Heat Transfer to Constant-Property Laminar-Boundary Wedge Flows With Stepwise Arbitrary Wall-Temperature Variations, by *S. Scesa* and *S. Levy,* University of California

Forced Convection From Nonisothermal Surfaces, by *John Klein* and *Myron Tribus,* University of Michigan

The Design of Wet Air-to-Air Heat Exchangers, by *J. M. Applegate,* AiResearch Manufacturing Co.

9:30 a.m.

Applied Mechanics (I)

Constant Strain Waves in Strings, by *J. D. Cole,* California Institute of Technology, and *C. B. Dougherty* and *J. H. Huth,* Rand Corp. (Paper No. 53—SA-4)

The Measurement of Acceleration Pulses With the Multifrequency Reed Gage, by *H. Shapiro,* Propulsion Research Corp., and *D. E. Hudson,* California Institute of Technology. (Paper No. 53—SA-8)

Dynamic Stress-Strain Relations for Annealed 2S Aluminum Under Compression Impact, by *J. E. Johnson,* Redstone Arsenal, and *D. S. Wood* and *D. S. Clark,* California Institute of Technology. (Paper No. 53—SA-7)

The Effect of Strain Hardening on an Annular Slab, by *P. G. Hodge, Jr.,* Brown University. (Paper No. 53—SA-20)

9:30 a.m.

Gas Turbine Power (I)

Experimental Investigation of Propagating Stall in Axial-Flow Compressors, by *T. Tura* and *W. D. Rannie,* California Institute of Technology

Design of Extremely Lightweight High-Speed Compressor Rotors for Aircraft Gas Turbines, by *J. S. Alford,* General Electric Corp.

9:30 a.m.

Safety (I)—Aviation (I)

Safety Vigilance in Air-Transport Operation, by *A. I. Salmon,* San Francisco Municipal Airport, United Airlines

The Engineer and Safety Engineering, by *Sidney D. Berman,* Norton Air Force Base

Statistical Trends in Air Safety, by *Ben W. Ashmead,* Civil Aeronautics Board

12:15 p.m.

President's Luncheon

Speaker: The President, *Frederick S. Blackall, jr.,* Fellow ASME

2:30 p.m.

Power (II)

Design of Steam Piping and Valves for 1100 Deg F, by *Frank A. Ritchings* and *Sabin Crocker,* Ebasco Services, Inc.

Fabrication of Austenitic-Steel Steam Piping for Operation at 1100 Deg F, by *W. G. Benz* and *R. H. Caughey,* The M. W. Kellogg Co.

2:30 p.m.

Management (II)

Quantitative Techniques in Measuring Worker Performance, by *A. J. Rowe,* University of Southern California

An Evaluation of Quantitative Techniques in Plant Layout, by *J. R. Huffman,* University of Southern California

A Critique of the Statistics of Time Study, by *R. T. Nelson* and *H. P. Edmundson,* University of California

2:30 p.m.

Heat Transfer (II)—Heat Transfer and Fluid Mechanics Institute (II)

Intermittent Heating of Airfoils on Ice Protection Utilizing Hot Air, by *H. H. Hauger, Jr.,* Douglas Aircraft Company, Inc.

Remarks on Film Condensation With Turbulent Flow, by *R. A. Seban,* University of California

Steady Temperature Fields in Electrical Coils by Membrane Analogy, by *P. J. Schneider* and *A. B. Cambel,* State University of Iowa

2:30 p.m.

Applied Mechanics (II)

Analysis of a Nonlinear Dynamic Vibration Absorber, by *L. A. Pipes,* University of California

Flexural Vibrations in Uniform Beams According to the Timoshenko Theory, by *R. A. Anderson,* U. S. Naval Ordnance Test Station

Flexural Wave Solutions of Coupled Equations Representing the More Exact Theory of Bending, by *Julius Miklowitz.* U. S. Naval Ordnance Test Station. (Paper No. 53—SA-6)

2:30 p.m.

Gas Turbine Power (II)—Aviation (II)

Development of Ramjet Power, by *N. F. Svendson* and *J. W. Braithwaite,* Marquardt Aircraft Co.

An Application of the Palouste Turbocompressor, by *O. H. Jacobson* and *B. Volkmer,* Northrop Aircraft, Inc.

2:30 p.m.

Process Industries (I)

A New-Type Radiant Tubular Heater, by *T. F. Kreipe,* Selas Corporation of America

Air Purification as a Means of Reducing Air-Conditioning Equipment and Duct Sizes, by *Norman Sharpe,* California State Polytechnic College

4:30 p.m.

Business Meeting

Presiding: The President, *Frederick S. Blackall, jr.,* ASME

8:00 p.m.

Junior

Speaker: *W. F. Nash, Jr.,* metallurgical consultant, C. F. Braun & Co.

TUESDAY, JUNE 30

8:30 a.m.

Registration

9:30 a.m.

Petroleum (I)

Development of Gas-Engine Compressor Plants, by *Lyman F. Scheel,* The Fluor Corporation, Ltd.

A Comparison of Electric Versus Steam Drives for Fluid Cracking Units, by *Hays C. Mayo,* The M. W. Kellogg Co.

9:30 a.m.

Aviation (III)

Air Conditioning the Super-Constellation, by *B. L. Messinger* and *H. M. Cousins,* Lockheed Aircraft Corp.

Air-Conditioning Design Features of the DC-7 Airplane, by *G. T. Rowe,* Douglas Aircraft Company, Inc.

9:30 a.m.

Power (III)—Hydraulic (I)

Features of Nuclear Power Plants of Interest to Power-Plant Engineers and Operators, by *R. A. Bowman*, Bechtel Corp.

Effect of Exhaust Pressure on the Economy of Condensing Turbines, by *A. Keller* and *J. E. Downs*, General Electric Co.

Prevention of Babbitt Blisters in Thrust-Bearing Pads, by *R. A. Baudry, D. W. Gunther*, and *B. B. Winer*, Westinghouse Electric Corp.

9:30 a.m.

Management (III)

Permanent Management—Labor Peace and Increased Production, by *Ethelbert Favary*, consulting engineer, Hollywood, Calif.

Industrial-Relations Training That Works, by *C. H. Shumaker*, Southern Methodist University

The Mutual Interests of Engineers and Management, by *W. J. King*, University of California

9:30 a.m.

Production Engineering (I)

A Plant-Wide Creative Cost-Reduction Program Under Purchasing Leadership, by *L. D. Miles*, General Electric Co.

Productionizing New Materials and Methods, by *H. W. Benjamin*, Lockheed Aircraft Corp.

9:30 a.m.

Applied Mechanics (III)

Measurements of Torsional-Stiffness Changes and Instability Due to Tension-Compression and Bending, by *H. L. Engel* and *J. N. Goodier*, Stanford University. (Paper No. 53—SA–5)

On Reinforced Circular Cutouts, by *E. Levin*, University of California

A Large Deflection Theory for Laterally-Loaded Doubly-Curved Rectangular Plates With Various Edge Conditions Including the Effects of Edge Members and Edge Forces, by *Coward Chang-Yen Wan*, United Aircraft Corp.

9:30 a.m.

Heat Transfer and Fluid Mechanics Institute (III)

Heat and Mass Transfer From Slender Cylinders to Air Streams in Axisymmetrical Flow, by *H. H. Sogin* and *Max Jakob*, Illinois Institute of Technology

Heat Transfer in the Compressible Turbulent Boundary Layer on a Flat Plate, by *Constantine C. Pappas* and *Morris W. Rubesin*, Ames Aeronautical Laboratory, NACA

Heat Transfer at Hypersonic Mach Number, by *R. D. De Lauer* and *H. T. Nagamatsu*, California Institute of Technology

9:30 a.m.

Metals Engineering (I)

Mechanical Aspect of Seizing in Metal Wear, by *Harry Czyewski*, Metallurgical Engineers, Inc.

Dynamic Properties of Nodular Cast Iron—Part 2, Size Effect, by *Harry Majors*, California Research and Development Co.

Lateral Forces Acting on a Press as a Result of Forging Operations, by *J. M. English*, University of California

12:15 p.m.

Petroleum Luncheon

Presiding: *H. L. Eggleston*, petroleum consultant

Speaker: *A. C. Rubel*, vice-president of Exploration and Production, Union Oil Company of California

2:30 p.m.

Petroleum (II)—Process Industries (II)

The Entrainment Problem and a Simple Solution, by *Sanford C. Reynolds*, Metal Textile Corp.

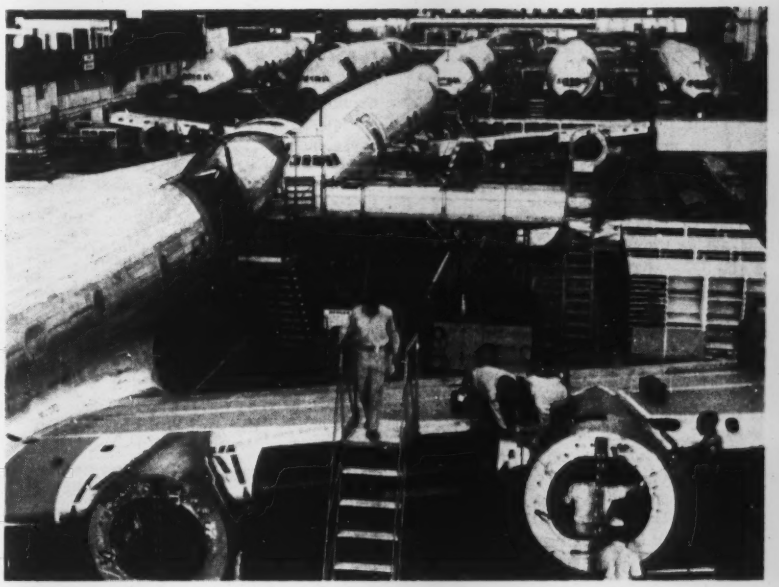
An Approach to the Sizing of Vapor Relieving Systems, by *J. Comson*, The Fluor Corporation, Ltd.

2:30 p.m.

Aviation (IV)—Materials Handling (I)

Modernization of the C-46 Air Freighter, by *P. W. Miller*, The Flying Tiger Line, Inc.

General Equations to Assist in the Comparative Economic Evaluation of Cargo-Type Aircraft, by *G. A. Busch*, Slick Airways, Inc.



LOCKHEED AIRCRAFT CORPORATION, BURBANK, CALIF.

(Assembly line scene *above* shows five fuselages under construction in rear. As planes in the foreground move down the line, those in the rear will be advanced to receive wings, engines, and tail assemblies. These Super Constellations are part of a large U. S. Navy order. They will fly long distances at 340–350-mph cruising speeds. Navy versions, seating 106, are convertible to carry cargo or hospital patients. Luxury commercial versions and freight models are on order for 13 World airlines. Special radar search models also will be built for military services.)

2:30 p.m.

Boiler Feedwater Studies (I)—Power (IV)

Progress in the Study of Corrosion in the Moisture Region of Large Steam Turbines, by *Trafford W. Bigger, J. F. Quinlan*, and *C. C. Carson*, General Electric Co.

Reduction of Condensate Line Corrosion, by *Scott Jensen* and *E. Russell Lang*, Southern California Edison Co. (Paper No. 53—SA–15)

Status of Investigation of Iron Oxide Deposition in Boiler-Feedwater System, by *E. G. Gothberg, Henry Kehmna*, and *E. S. Johnson*, Pacific Gas & Electric Co. (Paper No. 53—SA–19)

2:30 p.m.

Production Engineering (II)

The Statistical Control of Production Processes, by *R. L. Fowlkes*, Northrop Aircraft, Inc.

Methods Engineering, by *L. C. Lander, Jr.*, General Motors Institute

2:30 p.m.

Applied Mechanics (IV)—Heat Transfer (III)

Temperature Distribution in the Wake of a Heated Sphere, by *D. H. Baer*, Phillips Petroleum Co., *W. G. Schlinger*, California Institute of Technology, *V. J. Berry*, Stanolind Oil and Gas Co., and *B. H. Sage*, California Institute of Technology. (Paper No. 53—SA–2)

Skin Friction and Heat Transfer for Laminar Boundary-Layer Flow With Variable Properties and Variable Free-Stream Velocity, by *S. Levy* and *R. A. Seban*, University of California. (Paper No. 53—SA–3)

The Rate of Growth of Vapor Bubbles in Superheated Water, by *Paul Dergarabedian*, U. S. Naval Ordnance Test Station. (Paper No. 53—SA–10)

2:30 p.m.

Heat Transfer and Fluid Mechanics Institute (IV)

Steady Interaction of Disturbances With a Shock Wave With Applications to Turbulence and Noise, by *H. S. Ribner* and *F. K. Moore*, Lewis Flight Propulsion Laboratory

Temperature Measurements in the Wake of Bodies in Supersonic Flow, by *A. H. Lange*, Naval Ordnance Laboratory

A Study of Shock-Wave Turbulent Boundary-Layer Interaction, by *Seymour M. Bogdonoff*, Princeton University

2:30 p.m.

Hydraulic (II)

The Source of Radial Forces in Centrifugal Pumps and Compressors, by *Ralph M. Watson*, Worthington Corp.

An Experimental and Theoretical Investigation of Two-Dimensional, Centrifugal-Pump Impellers, by *Allen James Acosta*, California Institute of Technology

7:00 p.m.

Banquet

Speaker: *L. A. DuBridge*, president, California Institute of Technology, Pasadena, Calif.

WEDNESDAY, JULY 1

8:30 a.m.

Registration

9:30 a.m.

Machine Design (I)

Twisting of Flexible Shafts, by *K. E. Bisshopp* and *D. C. Drucker*, Brown University

Methods Used in Investigating Gear-Tooth Loading in the Colmol, by *James A. Flint*, The Jeffrey Manufacturing Co.

9:30 a.m.

Aviation (V)—Gas Turbine Power (III)

Propulsion Wind Tunnels of the Arnold Engineering Development Center at Tullahoma, Tenn., by *Frank L. Wattendorf*, U. S. Air Force, *John Noyes*, Sverdrup & Parcel Inc., and *A. I. Ponomareff*, Westinghouse Electric Corp.

The Use of Stator Blade Control to Obtain Wide Range of Compressor Performance for Wind-Tunnel Applications, by *A. W. McCoy*, Sverdrup & Parcel Inc., and *M. J. Brunner*, Westinghouse Electric Corp.

ASME National Nominations

THE 1953 Nominating Committee is to meet for two days June 29–30, 1953, at the Hotel Statler in Los Angeles, Calif., where the Semi-Annual Meeting will be held. Open hearings will be held so that members may speak in behalf of their candidates for the office of President, Regional Vice-President, and Directors at Large any time between the hours of 10:30 a.m. to 12 noon; and from 2 p.m. to 5 p.m. on Monday, June 29, and on Tuesday, June 30, from 9:30 a.m. to 12 noon and, if necessary, from 2 p.m. to 5 p.m. Following the close of business of the 1953 Nominating Committee there will be held an Organization Meeting of the 1954 Committee presided over by A. R. Weigel, chairman of the 1953 Committee. This meeting will take place on Tuesday afternoon or evening, June 30, following the Business Meeting of the 1953 Committee or, if necessary to extend the Business Meeting through Tuesday evening, the Organization Meeting will be held on Wednesday morning, July 1.

9:30 a.m.

Boiler Feedwater Studies (II)—Power (V)

The Mitigation of Marine Fouling by Anaerobic Treatment, by *H. T. Duplice* and *R. C. Alexander*, Department of Water & Power, City of Los Angeles

Zeolite Versus Soda Ash in Hot-Process Softener at Firestone, by *W. F. Fields*, Firestone Tire & Rubber Co. (Paper No. 53—SA-13)

The Recirculating Cooling-Water System at Tucson, by *H. J. Saunders*, The Tucson Gas, Electric Light & Power Co. (Paper No. 53—SA-14)

Operation of Outdoor Demineralizing Units, by *A. A. Lingo*, California Electric Power Co.

9:30 a.m.

Production Engineering (III)

Organization of Industrial Engineering in a Small Company, by *A. M. Elliott*, Lenkurt Electric Co.

Organization for Production Engineering, by *R. H. McCarthy*, Western Electric Co.

9:30 a.m.

Fuels

Smokeless Burning of Waste-Process Gases, by *Robert DeHart Reed*, John Zink Co.

Offshore Deliveries of Fuel Oil From Tank Ships Through a Submarine Line at Moss Landing Steam Plant, by *E. A. Salo*, Pacific Gas & Electric Co., and *S. P. Johnson*, Standard Oil Company of California

Experimental Study of Combustion in Rockets, by *Charles H. Trent*, Aerojet Engineering Corp.

9:30 a.m.

Inspection Trip

Lockheed Aircraft Corporation, Burbank, Calif.

9:30 a.m.

Heat Transfer and Fluid Mechanics Institute (V)

Turbulent Forced-Convection Heat Transfer in Circular Tubes Containing Molten Sodium Hydroxide, by *H. N. Hoffman*, Oak Ridge National Laboratory

Free Convection in a Uniform Electric Field, by *G. H. Halsey* and *K. H. Weber*, General Electric Co.

Heat Transfer in Curved Flow Channels, by *Frank Kreith*, University of California

12:15 p.m.

Aviation and Gas Turbine Power Luncheon

Presiding: *R. Q. Roosman*, design engineer, aviation director of local division, Lockheed Aircraft Corp., Burbank, Calif.

Speaker: *George Prudden*, director of quality control, Lockheed Aircraft Corp., Burbank, Calif.

Subject: **Adam Couldn't Fly**

2:00 p.m.

Inspection Trips

French Sardine Company, Exchange Lemon Products Company, C. F. Braun Corporation, Lever Brothers Company, and Hyperion Treatment Plant

2:30 p.m.

Heat Transfer and Fluid Mechanics Institute (VI)

Status of Information on Nucleate Boiling, by *Warren Rohsenow*, Massachusetts Institute of Technology

Formation of Bubbles at Simple Orifices, by *R. R. Hughes, A. E. Handlos, H. D. Evans,* and *R. L. Maycock*, Shell Development Co.

Factors That Influence Heat Transfer in Boiling, by *R. F. Larson*, University of Illinois

2:30 p.m.

Aviation (VI)—Machine Design (II)—SAE (I)

Production Capabilities of Large Extrusion Presses and Auxiliary Equipment, by *G. E. Moni*, Reynolds Metals Co.

Panel Extrusions in Aircraft Structures, by *Howard Kastan*, Lockheed Aircraft Corp.

Light-Alloy Forging Design and Production Problems as Related to Heavy-Press Operations, by *A. E. Favre*, Aluminum Company of America

8:00 p.m.

Aviation (VII)—Machine Design (III)—SAE (II)

Design Considerations Associated With Large Aluminim Forgings, by *C. W. Andrews*, Douglas Aircraft Co.

8:00 p.m.

Heat Transfer and Fluid Mechanics Institute (VII)

Fluid-Flow Analogs for Solving Heat-Conduction Problems: A Fluid Mapper Lecture-Demonstration

A. D. Moore, University of Michigan

The field of heat flow in a heat-conduction case can be visually simulated in a fluid-flow analog. Such analogs, called "fluid mappers," have been developed in new forms by Professor Moore in recent years, at the University of Michigan. The fluid flow occurs between a glass plate, and a plaster slab tailored to fit the case.

A slab will be cast, finished, and operated in a fluid mapper to show the flow pattern. Audiences are invariably fascinated by the plaster-handling techniques, and the many beautiful flow patterns that are shown by the color slides. Nearly half a hundred fluid-mapper demonstrations have been given throughout the country to colleges, research institutes, societies, and industrial firms.

THURSDAY, JULY 2

8:30 a.m.

Registration

9:30 a.m.

Metal Processing (I)—Production Engineering (IV)—Aviation (VIII)

The Friction Terms in Metal Cutting, by *William C. Leone* and *Edward A. Saibel*, Carnegie Institute of Technology

Machining Integrally Stiffened Structures, by J. C. Borger, Lockheed Aircraft Corp. (Paper No. 53—SA-21)

9:30 a.m.

Education

Looking Ahead in Engineering, by *L. M. K. Boelter*, University of California

What Are the Requirements of Postgraduate Education in Engineering? by *William Bollay*, Aero Physics Development Corp.

9:30 a.m.

Oil and Gas Power

Valve-Gear Fundamentals for the Large-Engine Designer, by *J. A. Newton* and *C. H. Allen*, Thompson Products, Inc.

Crankwebs, Including Arcweb Design, by *S. W. Newell*, The Union Diesel Engine Co.

9:30 a.m.

American Rocket Society (I)

Correlation of Experimental Data on the Disintegration of Liquid Jets, by *C. C. Miesse*, Aerojet Engineering Corp.

Combustion in Rocket-Thrust Chambers as Investigated by a Mechanical Probe, by *Charles Trent*, Aerojet Engineering Corp.

Rocket-Powered Wind Tunnel, by *Frank reith, P. G. Stewart,* and *E. S. Starkman*, University of California

C. F. BRAUN & COMPANY HEADQUARTERS AND PLANT

(Visitors to the 1953 Semi-Annual Meeting will have the opportunity of visiting the engineering headquarters and fabricating plant of C. F. Braun & Company. The 50-acre properties to be inspected include a $2 million research laboratory, an engineering center, and a manufacturing plant producing specialized process equipment.)

9:30 a.m.

Instruments and Regulators (I)

Development of an Automatic Data Plotter, by *John H. Weaver,* Telecomputing Corp.

The Oscar, a New Approach to the Analysis of Oscillographic Records, by *Bernard S. Benson,* Bernard-Lehner Corp.

Automatic Calibration of Transducers, by *John Kinkel* and *R. Mauson,* Consolidated Engineering Corp.

9:30 a.m.

Heat Transfer and Fluid Mechanics Institute (VIII)

Cavitation and Cavitation Damage—Survey of Present Status of Knowledge, by *R. T. Knapp,* California Institute of Technology

On the Normal Shock Wave in Any Single-Phase Fluid Substance, by *S. J. Kline,* Stanford University, and *Ascher H. Shapiro,* Massachusetts Institute of Technology

Open-Channel Flow of Water-Air Mixtures, by *H. A. Einstein* and *O. Sibul,* University of California

12:15 p.m.

American Rocket Society Luncheon

Presiding: *B. L. Dorman,* Aerojet Engineering Corp., Azusa, Calif.

Speaker: *Major C. E. Yeager,* Air Force, Experimental Flight Test Center, Edwards Air Force Base, Calif.

Subject: **Experiences in Rocket-Propelled Aircraft**

12:15 p.m.

Heat Transfer Luncheon

Presiding: *H. B. Nottage,* Propulsion Research Corp., Inglewood, Calif.

Speaker: *Benjamin Pinkel,* Lewis Flight Propulsion Laboratory, NACA, Cleveland Airport, Cleveland, Ohio

Subject: **Summary of NACA Research on Heat Transfer and Friction for Air Flowing Through Tubes With Large Temperature Differences**

2:30 p.m.

Metal Processing (II)—Production Engineering (V)

Machining High-Tensile-Strength Steel, by *Fred M. Rayburn,* Menasco Manufacturing Co.

Predicting the Angle of Chip Flow For Single-Point Cutting Tools, by *L. V. Colwell,* University of Michigan

2:30 p.m.

Materials Handling (II)

The Trend Toward Automation in Automatic Weighing and Bulk-Materials Handling, by *Ingram Richardson,* Richardson Scale Co.

2:30 p.m.

Lubrication—Machine Design (IV)

The Dynamics of Lubrication of a Miniature Turbine Rotor on Porous Bushings, by *George Sines.*

The Nonsteady-State Operation of Tilting-Pad Slider Bearings, by *J. F. Osterle, A. Charnes,* and *Edward Saibel,* Carnegie Institute of Technology. (Paper No. 53—SA-1) (To be presented by *William Leone,* Carnegie Institute of Technology.)

2:30 p.m.

American Rocket Society (II)

Application of Aerodynamic Theory in the Design of Large Unguided Artillery Rockets, by *A. L. Shef,* Douglas Air Craft Corp.

Air-Transportable 10-Ton Per Day Liquid Generator, by *C. L. Jewett,* Arthur D. Little, Inc.

Solid Propellent Rockets—Basic Concepts, Present Status, and Trends in Development, by *C. E. Bartley,* Grand Central Aircraft Co.

Instruments & Regulators (II)—Aviation (IX)

Application of Magnetic Recording to Flight-Test Instrumentation, by *Myron J. Stolaroff,* Ampex Electric Corp.

Multichannel Dynamic Recording—A Powerful Tool for the Design Engineer, by *Willard T. Young* and *John Terbox,* Consolidated Engineering Corp.

2:30 p.m.

Heat Transfer and Fluid Mechanics Institute (IX)

Recent Advances and Current Problems in the Theory of Flame Propagation, by *Martin Summerfield,* Princeton University

On the Stability of Heterogeneous Systems, by *C. C. Miesse,* Aerojet Corp.

Evaporation From Liquid Wall Films Into a Turbulent Gas Stream, by *Eldon L. Knuth,* California Institute of Technology

Women's Program

Sun., June 28, registration, 9:00 a.m.—9:00 p.m.
Mon., June 29, President's Luncheon, 12:15 p.m.; studio tour, 2:00 p.m.
Tues., June 30, Huntington Library, at noon; reception and banquet in the evening
Wed., July 1, Knott's Berry Farm, 10:00 a.m.
Many other trips in and around town are presently being arranged.

ASME Membership as of March 31, 1953

Honorary Members	52
Fellows	380
Members	13,445
Associates	338
Juniors (33 and over)	3,432
Juniors (30-32)	1,993
Juniors (to the age of 29)	16,964
Total	36,604

25th OGP Division Conference and Exhibit Tentative Program Announced

THE program under way for the Conference and Exhibit of the Oil and Gas Power Division of The American Society of Mechanical Engineers, to be held at the Hotel Schroeder, Milwaukee, Wis., May 25-28, 1953, is comprised of technical sessions where the latest information on design, operating, and maintenance developments will be discussed and inspection trips to Milwaukee's leading industries; and highlights an exhibit where some forty-five to fifty new engines and accessories will be displayed.

A special program has been arranged for the women attending the meeting which includes sight-seeing and social hours. As always, the ladies are cordially invited to attend the Welcome Luncheon, Banquet, and the Milwaukee Section party.

The tentative program follows:

MONDAY, MAY 25

8:30 a.m.

Registration

10:30 a.m. Session 1

Package Units for Utilizing Waste-Heat Energy, by *Robert C. Coblentz,* president, Coblentz Equipment Co., Erie, Pa.

12:30 p.m.

Welcome Luncheon

Presiding: *A. W. Colwell,* chairman, Milwaukee Section, ASME; A. O. Smith Corp., Milwaukee, Wis.

OGP History: *P. B. Jackson,* Development Division, Aluminum Company of America, Cleveland, Ohio

Speaker: *Harry Brockel,* Milwaukee Harbor Commission

2:00 p.m. Session 2

Valve-Gear Fundamentals for the Large-Engine Designer, *J. A. Newton,* chief engineer, Valve Division, and *C. H. Allen,* sales engineer, Valve Division, Thompson Products, Inc., Cleveland, Ohio

8:00 p.m. General Technical Committee Meeting

Ignition Systems for High-Compression Gas Engines, Panel to consist of representatives from the Cooper-Bessemer Corp., Fairbanks-Morse and Co., Nordberg Mfg. Co., and the Worthington Corp.

TUESDAY, MAY 26

8:30 a.m.

Registration

9:30 a.m. OGP Special Lecture

The Cast Ferrous Metals, *T. E. Eagan,* research metallurgist, The Cooper-Bessemer Corp., Grove City, Pa.

2:00 p.m. Panel Discussion

Diesel Plant Design, Panel Members, *W. C. Fischer,* manufacturer of engineering, Fairbanks-Morse and Co., Milwaukee, Wis.; *Robert Cramer, Jr.,* assistant chief engineer, Nordberg Manufacturing Co., Milwaukee, Wis.; *Lyle B. Brady,* assistant superintendent, Municipal Power Plant, Rochelle, Ill.; *John W. Cramer,* partner, Fulton & Cramer, consulting engineers, Lincoln, Neb.; *Sanford K. Fosholt,* partner, Stanley engineering Co., Muscatine, Iowa

7:00 p.m.

Banquet

Presiding: *A. W. McKinney,* president, Diesel Engine Manufacturer's Association, Chicago, Ill.

Speaker: *Frederick S. Blackall, Jr.,* president, ASME; president, treasurer, The Taft-Peirce Manufacturing Co., Woonsocket, R. I.

Subject: **Western Europe Through an Engineer's Eyes**

WEDNESDAY, MAY 27

8:30 a.m.

Registration

9:30 a.m. Session 3

A Photographic Study of Events in a 14-Inch, Two-Cycle Gas Engine, *Ralph L. Boyer,* vice-president and chief engineer, and *Dwight Craig,* research engineer, The Cooper-Bessemer Corp., Mount Vernon, Ohio, and *C. D. Miller,* assistant supervisor, Battelle Memorial Institute, Columbus, Ohio

Investigation of Flame Temperatures in a Single-Cylinder Spark-Ignition Engine, *James H. Potter,* professor of mechanical engineering, and *Robert B. Dillaway,* instructor of mechanical engineering, University of Illinois, Urbana, Ill.

2:00 p.m. Session 4

Two- and Four-Cycle Results of Medium-Speed Engines on Heavy Fuel, *Russell Pyles, J. M. A. Van Der Horst,* and *D. C. Cryor,* Van Der Horst Corporation of America, Olean, N. Y.

The Production and Utilization of Residual Fuels, *E. Albright, C. E. Habermann, W. F. Hergruter,* and *C. W. Hoffman,* Socony-Vacuum Oil Co., Inc., New York, N. Y.

6:30 p.m.

Buffet Dinner and Entertainment

THURSDAY, MAY 28

8:30 a.m.

Registration

9:30 a.m. Session 5

Arcweb Crankshaft Design, *S. W. Newell,* vice-

president, The Union Diesel Engine Co., Oakland, Calif.

The Tuned Manifold or Supercharging Without a Blower, *H. W. Engleman,* mechanical-engineering department, University of Wisconsin, Madison, Wis.

2:00 p.m.

Inspection Trip

Nordberg Manufacturing Co.

FRIDAY, MAY 29

9:00 a.m.

Inspection Trip

Fairbanks-Morse Beloit Plant

Hardwood Exhibit Featured at Chicago Museum

THOMAS D. Perry, Fellow ASME, long active in the Wood Industries Division of The American Society of Mechanical Engineers, attended the dedication of the Hardwoods Exhibit at the Museum of Science and Industry, in Chicago, Ill., on March 19, 1953. He was the chief consultant to the staff of the Museum in developing the graphic tests which demonstrate the useful qualities of plywood and adhesives.

The exhibit starts with the tree, in which the growth processes are shown by lights, continues through miniature models of all conversion processes, sawing logs, cutting veneer, gluing plywood, and so on, and concludes with full-size showings of furniture, musical instruments, sports equipment, and the like, which contribute to human comfort and recreation. There are many exhibits where the push of a button activates a dramatic demonstration of the qualities and uses of plywood and adhesives. This exhibit was underwritten by all segments of the hardwood industry at a cost of over $350,000 and is modernly displayed with the aid of sound-movies, colors, and lights. Last year these museum exhibits, in many industries, accommodated over two million visitors.

"Horse Sense" Adds to Value of Engineers

AMERICAN industry can multiply the effectiveness of its technical manpower by replacing the "ivory-tower perfectionism" of some engineering attitudes with "old-fashioned horse sense."

This proposition was placed before the American Management Association's manufacturing conference in New York, N. Y., recently by George M. Muschamp, Mem. ASME, executive of a company which earns much of its living putting new perfection into old processes.

Mr. Muschamp, vice-president of engineering of Brown Instruments Division of Minneapolis-Honeywell Regulator Company, told his audience at the Hotel Statler that "straight thinking" on engineering would keep projects within the framework of "what will it cost and how long will it take?" Much engineering manpower and many development dollars, he said, are wasted on "technique for technique's sake" when simpler methods would do the job as well for less.

In this time of acute shortage of engineers, Mr. Muschamp added, it is particularly important to use good administrative handling which can add months to an engineer's productivity. He recommended that engineers be taught better evaluation and target-setting habits, to reconcile their technical viewpoints with the goals of their employers.

Some "plain economics" must be injected into what is otherwise a complicated technical situation, Mr. Muschamp said. To do so, he suggested that management foster a high delegation of responsibility and an even higher degree of self-management at lower levels.

"The further down the line you can push responsibilities and have them adequately discharged, the more efficient you will be.

"These steps, plus improved integration between research, design, and production has enabled us to get maximum mileage from our own engineers."

Lest some firms still put reliance on various recruiting lures, Mr. Muschamp pointed out that only 19,000 engineers will graduate in June—and some 4000 later in the year—to fill over 40,000 jobs open this year for engineers.

Industrial Engineering Institute Held at the University of California

MORE than 800 people attended the fifth annual Industrial Engineering Institute at the University of California at Los Angeles, between January 31 and February 3. The series of meetings were held in co-operation with The American Society of Mechanical Engineers, the American Institute of Industrial Engineers, the Society for Advancement of Management, the Society of Applied Industrial Engineers, and the American Society for Quality Control.

Chairmen of the Institute

The general chairman for the Institute was D. G. Malcolm, Jun. ASME, vice-president, Bacon Vulcanizer Manufacturing Company. Almost identical programs were held first at the Berkeley campus on January 31 and February 1, and at the UCLA campus on February 2 and 3. The chairman for the Institute Program at the Berkeley campus was B. G. McCauley, Jun. ASME, assistant professor of mechanical engineering, University of California, Berkeley, and the chairman at UCLA was R. M. Barnes, Mem. ASME, professor of engineering and production management at UCLA.

High Lights of the Program

The morning session of the first day included a discussion of job evaluation by M. R. Lohmann, professor of industrial engineering and vice-dean, Oklahoma A&M College, and a discussion of "Incentives for Indirect Labor," by George Gustat, superintendent of industrial-

PARTICIPANTS AT THE INDUSTRIAL ENGINEERING INSTITUTE

(Shown *left to right:* Ellis A. Johnson, director, Operations Research Office, The Johns Hopkins University, who gave a talk on "The Applications of Operations Research"; C. M. Sandland, chairman, Southern California Section, ASME, who acted as chairman at the session; and L. D. Miles of the purchasing department, General Electric Company, who discussed "Cost Reduction in the Purchasing Function.")

engineering division, Eastman Kodak Company, Kodak Park, Rochester, N. Y. Dr. Barnes was chairman of the morning session. Duane Orton, director of education, International Business Machines Corporation, New York, N. Y., discussed "Job Enlargement—Imperative Problem of Industrial Engineering."

An evening session at UCLA was devoted to quality control, at which Major General Leslie E. Simons, assistant chief of Ordnance and chief of Research and Development, United States Army, Washington, D. C., discussed "Building Reliability into Complex Equipment Through the Application of Quality-Control Procedure."

The second day's program included a discussion by L. D. Miles, purchasing department, General Electric Company, Schenectady, N. Y., on "Cost Reduction in the Purchasing Function," and a discussion of the application of operations research to industry by Ellis A. Johnson, director, Operations Research Office, The Johns-Hopkins University. Lillian M. Gilbreth, Hon. Mem. ASME, president, Gilbreth Incorporated, Montclair, N. J., discussed the future of industrial engineering.

Stewart M. Lowry, Western Region coordinating partner, Booz, Allen and Hamilton, San Francisco, Calif., talked about the industrial-engineering function in medium-sized business, and C. Lloyd Thorpe, Mem. ASME, general personnel and public-relations manager of the Guy Atkinson Company, South San Francisco, discussed "Industrial Engineering, Planning, and Control for Small Manufacturing Plants."

Other meetings included reports of researches being carried on at the University of California in the general field of industrial engineering.

Proceedings of the Institute are available through the Extension Division of the University of California.

INDIA'S NEHRU HONORS H. A. KULJIAN

(American engineers and technical skills received glowing tribute from Prime Minister Nehru, *right*, at the dedication of the first unit of India's "TVA"—the Bokaro Steam Power Plant near Calcutta. Harry A. Kuljian, *left*, Fellow ASME, Philadelphia, Pa., engineer whose firm designed and built the $35 million plant, was warmly praised by Nehru for completing the gigantic power project in record time. According to Nehru, the completion of this project will make possible an immense industrial build-up and brighter living conditions for this whole area of central India.)

ASME Elects Four Fellows

THE American Society of Mechanical Engineers has honored four of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men whose outstanding contributions to their profession and to the Society were so honored are:

Clement J. Freund

CLEMENT J. FREUND, dean, college of engineering, University of Detroit (Mich.), has made outstanding contributions in the field of engineering education. Since he became dean in 1932 at the University of Detroit, he has, among other accomplishments, completed successive revisions of curricula for greater emphasis upon engineering fundamentals and the sciences, and humanistic-social studies; has established a summer school and an evening school for engineering students; and brought about the adoption of policies for administration of co-operative employment relations. In addition, he organized the vocational-guidance project of the Engineering Society of Detroit, now serving about 1000 high-school students a year. From 1924 to 1932 he was associated with the Falk Corporation, in the organization and guidance of the "Milwaukee Plan" of industrial apprenticeship for the schooling of young engineers in industry. Since 1944 he has been consultant to the Falk Corporation in a project for the grooming of selected engineers for advanced responsibilitie . His extensive work in national and local engineering societies is widely known. He inaugurated the highly successful annual conferences on Relations With Industry of the American Society for Engineering Education and was president of this society in 1948–1949. He has done much work for the Engineering Society of Detroit, and served as president, 1946–1947, the Engineers' Council for Professional Development, and many others. He has been active in ASME affairs, serving both as member and chairman of: the Committee on Education and Training for Industries, the Committee on the Economic Status of Engineers, and the ASME Detroit Section. Dean Freund is the author of many papers.

Eric Hanover Garrett

ERIC H. GARRETT, general manager, Kendrick and Davis Company, Lebanon, N. H., is known for his work as an executive and as a design engineer, having done much new design work on watchmakers' tools and electric motors (small). In 1940 he designed a new staking tool to do watch jeweling, other staking tool operations, and various attachments to aid in watch and instrument repair. Mr. Garrett joined Kendrick and Davis in 1919 as assistant superintendent in charge of design and production on small electric motors and special applications of small motors. He became superintendent in 1928 taking charge of design and production methods for small motors and watchmakers' tools. In his present position since 1929, he has full responsibility for purchasing, sales, manufacturing, design, labor, and methods of the company. During the first world war he worked for the Canadian Munitions Board in the inspecting and testing laboratories, and later as chief inspector on munitions work of the American Steam Gage and Valve Company, Boston, Mass. Following this, he was tooling engineer with Canadian Standard Products, St. Catherines, Ont., Can., where he was connected with setting up an entire new factory for mass production of fuses for the United States. Mr. Garrett has engaged in many civic activities such as water works, budget control committee, and the like. He served the Society for two years as chairman, Green Mountain Section. He has developed several patents, one of which was the first practical electric-phonograph drive.

C. S. N. Raju

C. S. N. RAJU, chief engineer, thermal power, Central Water and Power Commission, Government of India, is an acknowledged specialist in his country in the field of thermal power-plant machinery. He has octupied the topmost grade of mechanical engineer in the Government for the past nine years, serving on several important technical committees. Mr. Raju was responsible for the planning, design, and initiation of construction of the 200,000-kw Bokaro Steam Power Station of the Damodar Valley Corporation. From 1938 to 1945 he was power engineer with the Tata Iron and Steel Company, Ltd., India, in full charge of their power stations, water-pumping stations, blast furnace, and bessemer converter-blower systems required for the steel plant. The steel plant produces normally more than a million tons of pig iron and 650,000 tons of finished steel a year. For the next two years Mr. Raju was deputy industrial adviser to the planning and development department, Government of India, working as secretary to the engineering panels for the manufacture of heavy engineering plants and machinery. In 1947–1948 he was technical adviser on plant and machinery to the Indian Liaison Mission, Tokyo, in charge of inspection of reparations of plant and machinery in Japan for his government. Later he was promoted to chief thermal power engineer, the position he now holds. Mr. Raju is the author of several important published technical reports including "Report on Industrial Plant and Machinery (Heavy) Panel" and report on "Road Rollers," published by the Government of India; reports on the design and location of the 200,000-kw Bokaro Steam

Power Station; and reports on the "Electric Power Generation in the State of Rajasthan," parts 1 and 2, and so on. He is the author of "Low Grade Coals of India and Their Utilisation for Thermal Power Generation," a paper read at the World Power Conference held in London, England, in 1950. He was graduated in India prior to his taking engineering studies at the Massachusetts Institute of Technology, U. S. A., where he received the degree of master of science in mechanical engineering in 1927.

Arthur M. Wahl

ARTHUR M. WAHL, advisory engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa., has done outstanding work in mechanical springs and the general field of stress analysis and application to complex problems. His pioneering research work during the past 26 years has given him an international reputation as a leading authority on stress analysis and mechanical springs. He has consistently contributed significant new knowledge to the general fields of mechanical engineering and applied mechanics and particularly in the field of stress analysis of machine parts. He has greatly enriched mechanical-engineering literature. Mr. Wahl has contributed approximately 50 papers to the technical press. He is the author of a book, "Mechanical Springs," published by Penton Publishing Co., 1944, and important chapters in both Marks's "Mechanical Engineers' Handbook" and Kent's "Handbook." Mr. Wahl joined Westinghouse in 1925 and from 1926 to 1946 was a research engineer with the laboratories. Since 1930 he has been in charge of the stress-analysis work at the laboratories, both in terms of functional investigations and solving specific research problems for all divisions of the company. Mr. Wahl was given the ASME Junior Award in 1929, and in 1949 the ASME Richards Memorial Award for outstanding work in mechanical engineering. He has served on many technical society committees including the ASME Special Research Committee on Mechanical Springs. He holds six patents.

People

ROGER F. WAINDLE, vice-president, Cannon-Muskegon Corporation, Muskegon, Mich., was elected president of the American Society of Tool Engineers at the twenty-first annual national meeting of the society. Among the other officers elected was R. C. W. PETERSON, Mem. ASME, owner, Peterson Engineering Company, Toledo, Ohio, as secretary.

* * *

W. O. HILDRETH, mechanical engineer, who was retired from the Syracuse plant of the Lamson Corporation a few years ago, received a citation on March 21 marking his 65-year membership in the Society. G. I. VINCENT, Mem. ASME, presented the citation at a little ceremony which was attended by Mr. Hildreth's friends and his son, Col. E. E. Hildreth.

EDWARD R. GRANNISS, Mem. ASME, manager, engineering and loss prevention department, Royal-Liverpool Insurance Group, New York, N. Y., has been elected chairman of the Safety Standards Board of the American Standards Association.

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HENNING A. FORSBERG, vice-president, Continental Foundry & Machine Company, East Chicago, Ind., received the 1952 Lorenz Memorial Gold Medal awarded by Steel Founders' Society of America. Presentation was made in Chicago, Ill., March 17, 1953, during the society's fifty-first annual meeting in the Edgewater Beach Hotel. A. J. MCDONALD, vice-president, American Steel Foundries, Chicago, Ill., was elected president of the society during the same meeting.

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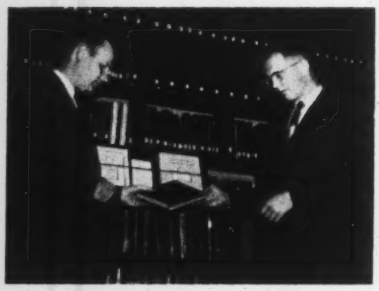
STANLEY STOKES, Mem. ASME, vice-president, Union Electric Company of Missouri, St. Louis, Mo., and F. K. POWELL, JR., director of engineering, American Machine & Foundry Company, New York, N. Y., were among the four native Missourians who received the Missouri Honor Awards for distinguished service in engineering at a special convocation held in Columbia, Mo., March 21, climaxing Engineers' Week at the University of Missouri.

* * *

H. RUSSELL BEATTY, Mem. ASME, has been named president of the Wentworth Institute of Boston, Mass. On July 1 he will succeed F. E. Dobbs, who is going to Pakistan to establish a technical institute similar to Wentworth.

* * *

I. F. KINNARD, engineering manager, meter and instrument department, General Electric Company, West Lynn, Mass., has been named recipient of the 1952 Lamme Gold Medal by the American Institute of Electrical Engineers. The medal will be presented during the AIEE summer general meeting, Atlantic City, N. J., June 15–19.



JUNIOR ENGINEERS SELECT BOOKS FROM ECPD RECOMMENDED LIST

(The display is part of a co-operative project emphasizing "The First Five Years of Professional Development" conducted in the Cincinnati area through the joint efforts of The Engineering Society of Cincinnati committees and the Engineers' Council for Professional Development. While the ESC Library is purely technical, no difficulty was experienced in gaining the co-operation of the local public library in furnishing a large number of books from the Reading List.)

ERNEST S. THEISS, vice-president, Region V, ASME, represented the president of the Society at the Case Institute of Technology Diamond Jubilee Convocation on "The Challenge to Free Men in the Atomic Age," which was held in Cleveland, Ohio, April 10 and 11.

* * *

ROBERT B. SOSMAN, professor at Rutgers University, and eminent authority on silica and refractories, received the sixth annual Albert Victor Bleininger Memorial Award from the American Ceramic Society.

* * *

CHARLES GORDON CURTIS, internationally-known inventor of the Curtis steam turbine, which was patented in 1896, died March 10, 1953. He also was credited with the invention of the first American gas turbine patented in 1899. In 1948 he received the first annual award of the ASME Gas Turbine Power Division for "pioneer work in the field of gas turbines."

Meetings of Other Societies

May 18–20
Metal Treating Institute, annual spring meeting, Shamrock Hotel, Houston, Texas

May 20–22
IAS, AIEE, IRE, and ISA, joint national telemetering conference, Edgewater Beach Hotel, Chicago, Ill.

May 20–22
Society of Photographic Engineers, third annual conference, Hotel Thayer, West Point, N. Y.

May 21–22
National Industrial Conference Board, thirty-seventh annual meeting, Waldorf-Astoria Hotel, New York, N. Y.

May 21–23
Society for Experimental Stress Analysis, spring meeting, Hotel Schroeder, Milwaukee, Wis.

May 25–28
Air Pollution Control Association, Lord Baltimore Hotel, Baltimore, Md.

May 27–28
American Iron and Steel Institute, general meeting, Waldorf-Astoria Hotel, New York, N. Y.

May 27–29
American Society for Quality Control, seventh annual convention, Convention Hall, Philadelphia, Pa.

June 1–4
Edison Electric Institute, twenty-first annual convention, Convention Hall, Atlantic City, N. J.

June 7–12
Society of Automotive Engineers, summer meeting, The Ambassador and Ritz-Carlton Hotels, Atlantic City, N. J.

June 15–17
Forest Products Research Society, seventh annual national meeting, Hotel Peabody, Memphis, Tenn.

June 15–17
American Society of Agricultural Engineers, annual meeting, William Penn Hotel, Pittsburgh, Pa.

June 15–19
American Institute of Electrical Engineers, summer general meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 15–19
American Society of Civil Engineers Convention, Casablanca Hotel, Miami Beach, Fla.

June 16–17
American Welding Society, national spring meeting, Shamrock Hotel, Houston, Texas

(*ASME Calendar of Coming Events, see page 429*)

More Women In Key Engineering Jobs Not Far Off

Women's Capabilities in Technical Fields a Proved Fact, says Worthington Executive

WITHIN the next five to eight years, women must be expected to play an increasingly important role in key engineering and technical capacities, according to J. J. Thompson, manager of the Personnel and Training Division, Worthington Corporation, Harrison, N. J.

Talking before a group of Worthington Product Division Managers and top-level executives at a national conference, Mr. Thompson said, "The time has now come when women who have mechanical leanings or technical abilities should seriously consider engineering as a career. Their opportunities for advancing in technical positions are increasing daily; and old prejudices, due to their sex, are rapidly melting.

"Over the years," Mr. Thompson pointed out, "women have made outstanding contributions in technical endeavors that were once considered only for men. To name a few, Katherine Stinson, chief of Specification Section, Aircraft Safety Division, CAA; Beatrice A. Hicks, vice-president and chief engineer of the Newark Boiler Regulator Company; Lillian M. Gilbreth, consultant, management engineering, Montclair, N. J.; Mabel M. Rockwell, production research engineer, Lockheed Aircraft Corporation; and Margaret McNally, civil engineer and contractor, Saginaw, Mich."

Mr. Thompson cited several women who have successfully invaded the engineering domains in the Worthington organization, with proved technical abilities; Louise Davis of the research and development laboratory at Harrison Works; Shirley Hoffman of the defense engineering department; Ruth George of the air-conditioning and refrigeration division; Bernice Amarotico, air-compressor and pumping-equipment application engineer, New York District Office; and Ethel Olson, power-transmission application engineer in the San Francisco District Office.

Mr. Thompson quoted from a recent survey by Frank S. Endicott, Director of Placement, Northwestern University, estimating the number of graduating engineers from colleges and universities in 1953 will be 23,000. Of these, approximately 14,000 will be available to industry, the remainder probably entering military service. The demand by industry in 1953 for engineering graduates has reached about 80,000.

In 1954 only 19,000 graduating engineers are expected. In 1955, 22,000; and in 1956, 29,000. By 1960 the supply of graduating engineers will have reached 40,000; but the demand, Mr. Thompson predicted, will be greater, rather than leveling off at the same rate.

This will be due, he said, "to a strong upward curve in research and development activities in the fields of nuclear energy and other advancements which will in turn create more of a demand in design, product, and application engineering. This will necessitate calling up reserves in the form of latent technical abilities, whether they be within men or women; and women will have the opportunity to compete with men for key engineering positions."

Opportunities for Young Engineers

THE chance of becoming "another Edison" is more than an idle dream to an expanding group of white-coated young laboratory assistants in the new $500,000 Edison Research Laboratory at West Orange, N. J.

Assisting scientists and engineers who have already attained wide reputations for high-level professional competence, the "Embryo Edisons" have a chance to learn by example from the best tutors using latest equipment for physical, chemical, and engineering research.

In the nearby Edison Museum, where organized industrial research was started 77 years ago, are the thousands of volumes of notes and comments from which Thomas A. Edison created 1097 inventions. These are available to provide inspiration to the young men, and their professional seniors, to find new applications, new designs, and new products.

And above all, there is financial assistance, beyond their pay checks, to help the youths in formal schooling toward engineering degrees, which would otherwise be beyond their reach.

It is doubtful that any other boys have ever had such an opportunity to achieve fame and fortune. It is equally doubtful that there is a complete parallel in American industrial history to this project which Thomas A. Edison, Inc., is underwriting.

The method for selecting these Embryo Edisons is one of the unusual features of the project. Each is a high-school graduate who has shown an aptitude for a scientific career, but whose financial status is such that higher education would be out of the question, even on a scholarship that did not carry a substantial financial grant.

The locale of the project also tends to make it unusual, for that nearby ivy-covered building which is now a museum, was the birthplace of such inventions as the motion picture, the fluoroscope and the first fluorescent lamp, the alkaline battery, and the modern method of cementmaking, among the many others.

The search for Embryo Edisons is one phase of an increased emphasis on research initiated shortly after Henry G. Riter, 3rd, was elected president of Thomas A. Edison, Inc., which continues to manufacture and market Ediphone dictating equipment, Edison instruments, batteries, medical gas, and nursery furniture.

As head of a company which Edison established with the proceeds of his first commercially practical invention—the stock ticker—Mr. Riter, after a survey by Dr. Foster C. Nix, an outstanding research consultant, and well known for his contributions to the wartime atomic-bomb project, pressed for expansion of research activities, under the direction of Dr. Donald W. Collier, 33-year-old research chemist.

The 77-year-old workshop of Edison, while eloquent as an inspiration to his successors, certainly had outlived its usefulness as an area for creative work. So, as a first step, the architectural firm of Harbeson, Hough, Livingston & Larson, of Philadelphia, Pa., was called upon.

This firm designed a one-story reinforced concrete functional structure to provide a total of 13,000 square feet of air-conditioned offices, laboratories, library, conference room, pilot plant, and machine shop, on which construction was completed within a year by The Fatzler Company, Inc., of Newark, N. J.

By May the new laboratory will be in full swing, carrying out basic and applied research in the present and future fields of all the operating divisions of Thomas A. Edison, Inc., even

ASME Calendar of Coming Events

May 22
ASME Textile Engineering Division, spring meeting, Sheraton Plaza Hotel, Boston, Mass.

May 24–28
ASME Oil and Gas Power Division Conference, Hotel Schroeder, Milwaukee, Wis.
(Final date for submitting papers was Jan. 1, 1953)

June 18–20
ASME Applied Mechanics Conference, University of Minnesota, Minneapolis, Minn.
(Final date for submitting papers was Feb. 1, 1953)

June 28–July 2
ASME Semi-Annual Meeting, Hotel Statler, Los Angeles, Calif.
(Final date for submitting papers was Feb. 1, 1953)

Sept. 21–25
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Sherman Hotel, Chicago, Ill.
(Final date for submitting papers was May 1, 1953)

Sept. 28–30
ASME Petroleum Mechanical-Engineering Conference, Rice Hotel, Houston, Texas
(Final date for submitting papers was May 1, 1953)

Oct. 5–7
ASME Fall Meeting, Hotel Sheraton, Rochester, N. Y.
(Final date for submitting papers—June 53)

Oct. 29–30
ASME Fuels Division and AIME Coal Division Joint Conference, Conrad Hilton Hotel, Chicago, Ill.
(Final date for submitting papers—June 1, 1953)

Nov. 29–Dec. 4
ASME Annual Meeting, Statler Hotel, New York, N. Y.
(Final date for submitting papers—July 1, 1953)
(For Meetings of Other Societies, see page 428)

though each of these divisions will retain its own product-engineering groups to supplement the work being done in the laboratory.

Men were added to Dr. Collier's staff even while the new building was under construction, and additional recruitment is contemplated in the face of the nationwide shortage of competent scientists and engineers.

It was from this very shortage, according to Dr. Collier, that the Embryo Edison plan evolved. Since the shortage appears to be a long-term one it was decided to experiment with a program to train carefully chosen high-school graduates, who might otherwise be lost to the technical-manpower pool. Four were engaged as laboratory assistants by day and entered in night classes at the Newark (N. J.) College of Engineering, with company financial aid toward their tuition and fees, provided they maintained satisfactory records. Thus the door was opened to boys with obligations of contributing to support of their families, from their earnings, and who were willing to undertake an eight-year program to attain their degree.

In effect, each Embryo Edison has been given eight years to make good—to achieve a degree in chemical, electrical, or mechanical engineering, and possible promotion to the professional staff of the Laboratory, or the technical staffs elsewhere in the company. Such promotion is not guaranteed, nor are the Embryo Edisons under any obligation to stay with the company.

While the program is scarcely a year old, Dr. Collier feels it worth while to the point of seeking more boys from the 1953 high-school graduating classes.

"There is no question," he says, "that we have opened a door to scientific careers to boys who might otherwise have to pass up college, and if successful, we will have made a worthwhile contribution toward solving the technical-manpower shortage.

"We need unusual boys—boys who are willing to undertake a long, hard grind. They receive the full pay of a laboratory assistant, plus full tuition and fees, if their school marks put them in the top third of their class, and half tuition if their scholastic record puts them in the second third.

"One other advantage of the plan is the fact that the boys see their learning applied as they go along; and, they are encouraged by the staff members to apply that learning themselves on the various live projects on which we are working.

"It must be admitted that the first group did not do as well as I had hoped in the first semester, but I am certain the boys can, and will, do better work at school. It is my theory that any student who 'scrapes by' should go into a subprofession, where he could probably excel, rather than come out as an inferior engineer."

Capuano Power-Plant Dedication Held in Naples

ALBERT C. Pasini, director at large, ASME, superintendent of Detroit Edison's St. Clair power plant and an authority in thermal-electric generation, went to Italy to attend the dedication of the new Capuano power plant in Naples, February 28.

The new 90,000-kilowatt Capuano station is equipped with boilers and turbines purchased in the United States with funds made available under the U. S. European Recovery Program. It is owned by the Italian utility known as the Societa Meridionale di Elettricita, and is an outstanding result of the ERP effort to provide power-short Italy with badly needed modern steam-electric generating facilities.

Until the beginning of World War II, more than 90 per cent of all the power developed in Italy was hydroelectric—that is, produced from falling water and therefore dependent on rainfall and other hydrologic conditions. During the war, construction of power plants was stopped entirely, and damage and deterioration were heavy. Low rainfall later aggravated an already severe power shortage.

The answer to the problem involved both machines and men. ERP made the needed equipment available. Then the U. S. Economic Cooperation Administration financed a technical-assistance program to teach Italian hydro-plant operators the quite different technique of running steam-electric generating stations.

Walker L. Cisler, Fellow ASME, Detroit Edison president and former ECA chief power consultant, served as an adviser in setting up the technical-assistance program. Teams of Italian plant operators were brought to the United States, trained in American thermal generating stations, and returned to Italy to assist in the construction and later in the operation of new facilities like those at the now-completed Capuano plant.

For Mr. Pasini, the dedication of the new generating station has a special significance, for in 1951 he trained a team of the Meridionale Company's men at Detroit Edison's Conners Creek plant, where he was then superintendent. The training problem was eased by the fact that Mr. Pasini is the son of Italian immigrants and has a good knowledge of the language. His close contact with the trainees smoothed out communication difficulties that might have slowed the program.

Mr. Pasini remained abroad for several weeks to discuss thermal-plant-operation problems with men of various utility companies throughout Italy.

DFI Inaugurates Writing Program

LATELY have reports by the Staff left something to be desired? The Designers for Industry, Inc., engineering consultants, have inaugurated with some success a program to foster a writing skill among its engineers and designers. The program consists of searching for fresh subjects and ideas in the problems of engineering and management which will have definite appeal to professional men, developing these ideas to a point where articles can be written, and subsequently submitting them to magazines and trade journals for publication.

When an engineer writes an article, it is submitted to the DFI Operating Committee for approval. If approval is obtained, the author is rewarded with a $25 bonus from the company. From this point the Operating Committee takes over in placing the article. When accepted for publication, the author receives another $25, thus assuring him of at least a $50 bonus for his efforts. In case of payment for an article, the author receives the full amount for the article in addition to the amount received from the company.

To date, several articles by members of this organization have been published on various phases of engineering management and design.

Several story folders have been set up for DFI personnel and are in various stages of development at this time. As a result of the program, DFI management believes that the engineering profession will be promoted in the eyes of its engineering personnel.

First New York TV Scientific and Engineering Career Conference

CLOSED-circuit theater television was used March 21 in seven theaters in the New York City metropolitan area to show high-school juniors and seniors the many opportunities for careers in science and engineering.

A one-hour morning program from 10 to 11 a.m., fed to the theaters from a central television studio, was followed by afternoon workshops at the Washington Square Center of New York University.

The novel method of demonstrating the great need for engineers and scientists in industry and government was sponsored by the Technical Societies Council of New York.

Co-operating agencies for this First Greater New York Scientific and Engineering Career Conference included the Public Service Committee of the Theater Television Industry, New York University, and the New York City Board of Education.

The program demonstrated the growth of engineering and science, its status today, and some of the great new developments of the future.

The program also gave live demonstrations of engineering theories and equipment, and modern developments in electronics, radio, aircraft, housing construction, atomic energy, and other scientific fields.

Seventeen afternoon workshops at New York University enabled students to get specific information on job opportunities, educational requirements, and salaries. Each session was addressed by a practicing engineer or scientist and a member of the faculty of one of the colleges and universities in the New York area.

Staff members of industrial firms, scientific and research foundations, and government laboratories, and faculty members of colleges and universities in New York City participated.

The President's Page

A Primer of Success

AMONG the great number of publications which our Society has produced over the years, there doubtless are many which deserve a far wider circulation than they have received. One such, which recently came to my attention, is "The Unwritten Laws of Engineering"[1] by Prof. W. J. King of the University of California. This capsule of wisdom has made such a profound impression upon me that I should like to commend it as required reading to every young engineer who is eager to grasp those principles and precepts which will lead almost unerringly to successful accomplishment in life. Indeed there is much in these brief pages that we oldsters would find rewarding, if only as a review course in axioms which most of us know but, alas, sometimes fail to follow. And this work is as applicable to other segments of business and professional life as it is to engineering.

The Executive Committee of Council recently ordered a reprinting of this in brochure form for distribution to all members of the Senior Class in the student branches of ASME. Professor King's wise guidance is presented in such convincing and easily assimilable manner that it should make an ideal manual of principles for the young engineering graduate. Indeed, it is a veritable primer of success.

Frederick S. Blackall, jr., *President*
The American Society of Mechanical Engineers

[1] Mechanical Engineering, May, June, and July, 1944. Reprints available.

H. A. Winne Predicts Engineering Advances to Be Faster

IN the next five to ten years engineering advances are likely to be faster than at any other time in history, according to Harry A. Winne, Hon. Mem. ASME, vice-president of engineering, General Electric Company, Schenectady, N. Y.

However, in accomplishing this, two major problems confront industry; one, where to find more engineers and two, how to get materials which will stand up under the ever-increasing stresses which designing engineers would like to place on them.

The demand for technically trained men and women far exceeds the supply, and engineers are approaching the limits of available materials, Mr. Winne said.

General Electric is attempting to alleviate the manpower shortage through utilization of its engineers to the best of their abilities and through a program to spur education. It is attacking the second problem by continuously seeking new fundamental materials and processes to meet the demand for smaller machines of higher speeds and greater output, he added.

One of the important projects of the G-E Research Laboratory is to obtain a better understanding of how to design alloys which will meet present-day engineering desires, Mr. Winne declared.

It has been generally accepted that industry needs 50,000 more scientists and engineers to satisfy the requirements of the stepped-up national defense program and anticipated increase in gross national product. The steady stream of new devices which have come from plants such as General Electric's has taxed the supply of engineers required to build and operate them.

The shortage has been made more acute by the low birth rate of the 1930's and the resulting lower enrollments in colleges. Another big factor in the industrial shortage of engineers has been the heavy demands made by the national government for the armed forces and for civilian engineers, Mr. Winne said.

Reviewing the technical-manpower situation, the G-E official foresees no easing of the situation in the years immediately ahead. Demands of the armed forces are likely to make bigger inroads on the engineer supply, since by 1956 it is expected that 62 per cent of that year's engineering graduates will be tapped for military service.

Indications are that by that time the armed services' demand for young men may wipe out all deferments, thus making further inroads into the supply of available engineers, although, of course, changes in the international situation can alter this materially.

To meet this situation, General Electric's program includes constant reviewing of its available engineers to utilize their full capabilities, use of engineering and laboratory assistants to free technically trained men for more important development work, and a program to encourage qualified high-school students to consider and prepare for engineering careers.

It is expected that 40,000 jobs will be available in 1953 to the 21,000 engineering graduates, and that 22 per cent of those graduating from engineering courses will be taken into military service. More than 5200 companies knocked at college doors during 1952 in search of engineers. General Electric is the largest industrial employer of engineers.

G-E president, Ralph J. Cordnier, recently reported that up to 30 per cent of the company's 1953 production would be for national defense. He also said that by 1961 the electrical-manufacturing industry's share of the gross national product, on the basis of 1940 prices, is expected to rise to 5.5 to 6.0 per cent as compared to about 4 per cent at present.

Vice-president Winne said that engineers expect to meet the problems of increased national defense requirements and of the gross national product as they arise. A good deal of the engineering for anticipated defense needs has been accomplished, but a stepped-up national defense program would have to be met as the situation warranted. The uncertainty of the Korean situation and the cold war make it impossible to predict what the demands will be.

Work in atomic power plants for submarines and airplanes will progress, but according to Mr. Winne, "atomic-electric power will be really economically sound only when it can compete with conventional electric power without requiring the subsidy of a government-supported weapons market. It could not do that today—unless in some very peculiar and unusual circumstances—nor, in my opinion, for a good many years to come."

Better use of available materials, more attractively appearing products and improved performances are some of the expectations of engineers for the products coming off assembly lines in the months ahead, he said.

Individual Engineers Can Help Overcome Shortage in Engineering

THE individual engineer has a responsibility along with industry and the schools in helping overcome the acute shortage of trained engineers, it was pointed out at the Fifth College-Industry Conference held at the Northwestern University Technological Institute, January 31.

The working engineer will be more effective if he: Acquires good personal habits and an understanding of personal motivations; keeps abreast of technological developments by taking advantage of postgraduation educational opportunities; appreciates the role of engineering in the light of its responsibility to humanity generally; and individually supports the efforts of industry, professional societies, and the schools in their efforts to train more technicians.

George A. Sievers, industrial psychologist of the Industrial Engineering Institute, Milwaukee, Wis., stressed the importance of being able to complete a job, not just start it, and the need for engineers to be conscious of their responsibility in co-operating with others.

"Calculus and mechanics may be prime requisites," he said, "but the engineer cannot do anything unless he knows how to work with people, his boss, his associates, and the people working under him."

Education has a partial responsibility in developing this philosophy, Carl W. Condit, assistant professor of English and Humanities at Northwestern, told the group of some 300 engineering executives and technical educators meeting at the one-day session.

"We know that specialization, as exact and thorough as it can be, is a necessity in the profession of engineering," Dr. Condit said. "Yet no good specialist with the qualities of leadership in industry and technology will result from narrow specialized training."

If engineers want to broaden their backgrounds, they should take advantage of the courses, conferences, and other classes offered by university extension services, night schools and the like, Homer L. Gammill, division of university extension, at the University of Illinois, told the audience.

Such education can supplement those things which did not fit into the formal curriculum before graduation, he pointed out. "The case for such education is based on the assumption that the engineer, like everyone else, finds himself in a fast-changing industrial world where he is constantly in need of additional knowledge."

While an engineer may be aware of the need for keeping up with new development in his own field, "unless he supplements his specialty with other knowledge he may fail to meet the demands of satisfactory living," Gammill asserted.

In another discussion from the viewpoint of the profession, Don P. Reynolds, of the American Society of Civil Engineers, New York, N. Y., noted that starting engineers and those at the peak of the profession are being well compensated.

"However," he pointed out, "there are many extremely productive men in the middle brackets who have become discouraged and embittered by failure of the recognition of the compensation to keep pace with the relative value of their professional efforts."

NCS Mechanical-Engineering Facilities Expanded

INSTRUCTIONAL and research programs of the department of mechanical engineering, North Carolina State College, Raleigh, N. C., have been considerably strengthened since the department took possession of its new quarters in the Broughton Mechanical Engineering Building last summer.

The building is a four-story, L-shaped structure containing approximately 52,000 sq ft of floor area. It contains 11 laboratories,

three design rooms, 10 classrooms, lecture rooms, and seminar rooms, as well as departmental and staff offices.

Much new and modern equipment has been purchased, complementing all that was moved from the department's old quarters. Some of the new equipment is still in the process of installation, but to a large extent all of the laboratories are in active use.

These new facilities are being used primarily for the instruction of engineering students. However, those which are applicable to research activities will also be utilized in the research programs of the school of engineering. They will supplement the mechanical-engineering research facilities of the department of engineering research, and will be available for use in the wide industrial and fundamental research activities of the school.

The power laboratory is the largest in the building, which also contains a heating and air-conditioning laboratory and two aeronautical laboratories. The metallurgy laboratory is used for both instruction and research. Other laboratories provide for the study of mechanical instrumentation, calibration, and experimental work on fuels and combustion.

1953 Resistance-Welding Contest Announced

A TOTAL of $2250 in prizes for outstanding papers on resistance-welding subjects will be awarded during the 1953 Prize Paper Contest of the Resistance Welder Manufacturers Association, in co-operation with the American Welding Society, according to a recent announcement. Separate prizes will be awarded to papers from engineers in industry and research laboratory work, papers from a university source, and those from undergraduate students. Papers on achievements in resistance-welding design, application, or research will be considered. The contest closes July 31, 1953. Awards will be made at the 1953 fall meeting of the American Welding Society. For further details, write the Resistance Welder Manufacturers Association, 1900 Arch Street, Philadelphia 3, Pa.

Industrial-Research Fellowships

A NUMBER of industrial-research fellowships in physics, chemistry, and chemical engineering, metallurgy, ceramics and minerals, engineering mechanics, and electrical engineering are being offered by Armour Research Foundation of Illinois Institute of Technology.

Research fellows will attend Illinois Institute of Technology half time and work in the Research Foundation half time in a graduate program leading to advanced academic degrees. They are employed full time by the Foundation during the summer.

The Foundation plans to award about 15 fellowships in 1953. Fellowships begin with the school semester in September, 1953, and continue through the summer for approximately 21 months until the end of the second academic year in June, 1955.

Awards are made on a competitive basis to U. S. citizens under 28 years of age holding a bachelor's degree from an accredited engineering or scientific school or a liberal arts college with a major in the sciences.

In addition to tuition, fellows are paid $165 a month during the first academic year, $325 a month with a two-week paid vacation during the summer, and $190 a month during the second year. Successful candidates are encouraged to accept full-time employment during the summer preceding the Fellowship at a rate of $300 a month.

Application forms may be obtained from the Office of Admissions, Graduate School of Illinois Institute of Technology. Applications received prior to March 15, 1953, will be given first consideration.

Coming Meetings

Air Pollution

PROBLEMS of air pollution will be one of the subjects discussed at the eleventh annual anthracite conference to be held May 7-8 at Lehigh University.

Louis C. McCabe, chief of the fuels and explosives division of the United States Bureau of Mines, Washington, D. C., will be the guest speaker. The sessions will be held in Packard Auditorium.

Other subjects to be discussed include tobacco curing with anthracite, stoker sales and service, activated carbon, new equipment, fuel-economy studies, and mechanical mining.

The conference, sponsored by the Anthracite Institute and Lehigh University, is designed to present up-to-date data on the technological progress in Pennsylvania's hard-coal industry.

Paris International Trade Fair

WORLD-WIDE interest and enthusiasm in the 1953 Paris International Trade Fair —to be held from May 9th through 25th—has exceeded expectations with an all-time record of 36 nations participating.

The Foire de Paris has become through the years the show place for the latest developments in industry and products. The systematic grouping of exhibits enables large technical sections to impressively display public works, mechanical and electrical-construction equipment; plastic materials; and packing, agricultural, building, foundry, refrigeration, and textile machinery. Not only a great technical trade fair, the Paris Fair features the finest examples of finished products in household equipment.

Permanently located at the Porte de Versailles since 1925, the Paris Fair is actually a handsome park ground of over 125 acres. Since its inception at the beginning of the century, the development of the Fair has been phenomenal.

Instrumentation in Water, Sewage, and Industrial-Waste Treatment

A CONFERENCE on instrumentation in water sewage, and industrial-waste treatment will be offered by the civil-engineering department of Manhattan College, New York, N. Y., May 14, 1953, with the sponsorship of the New York City Board of Water Supply and the New York City Department of Public Works and with the co-operation of the Metropolitan Section of the Instrument Society of America. Several companies in the instrument field are also offering their support.

Panels will be held on the following topics: Design of flow-control systems, process instrumentation and control in water treatment, instrumentation and control of activated sludge processes, instrumentation and control of sludge digestion.

Industrial Research

THE fourth annual conference on Industrial Research, sponsored by the school of engineering of Columbia University, will consider the problems of co-ordination and control of industrial research during the week of June 1-5, 1953.

Attendance at the conference will include research administrators from a cross section of U. S. industry, and from very small laboratories to some of the largest in the country.

The subjects to be covered this year include: Co-ordination of research with sales, co-ordination with product design, co-ordination with the financial aims of the company, co-ordination with the production operations, co-ordination with the quality objectives of the company, internal co-ordination of the research activity, internal control of research, and the economic future of research.

In addition to formal sessions, with prepared papers on these subjects, small discussion sessions will be held throughout the week to consider specific problems of the conferees.

Railway Congress

THE eighth Pan-American Railway Congress will be held in the United States beginning June 12, 1953, and will continue for about two weeks. Sessions will be held in Washington, D. C., from June 12 to 20 and in Atlantic City, N. J., from June 21 to 25, where the latest in railroad equipment and supplies will be exhibited. The railway congress is expected to bring to the United States several hundred delegates from the governments of twenty Latin-American countries.

ASEE Convention

THE 61st annual convention of the American Society for Engineering Education will be held June 22-26, inclusive, at the University of Florida in Gainesville. This year's host institutions—the University and the State of Florida—are making every effort to arrange a technical program of unusual merit, coupled with a recreational program of the type that has made Florida one of the favorite vacationlands of the United States.

In addition to an outstanding technical program in the field of engineering education, considerable attenti on will be given to the currently vital problems of manpower utilization and industrial expansion.

Industrial Research

THE fourth annual conference on industrial research sponsored by the department of industrial engineering, Columbia University, will be held during the week of June 1–5, at the Arden House Campus of the university.

The theme of this year's conference, co-ordination and control of research operations, includes papers, discussions, and clinic sessions on co-ordination of research with the financial aims of the company; co-ordination with sales; co-ordination with production design; co-ordination with production; internal co-ordination of the research operation; internal control; co-ordination with the quality objectives of the company; and other related topics.

In addition to the formal sessions, small discussion groups will be held throughout the week to consider specific problems of the attendees. The Proceedings of the Conference will be published again this year. Copies of proceedings of previous conferences are available from the Columbia University Press.

Canadian International Trade Fair

THE machinery and plant-equipment section of the Canadian International Trade Fair is already well ahead of last year in both size and variety of exhibits, as well as in the number of countries represented.

This year's Trade Fair, to be held in Toronto, Ont., Can., from June 1 to June 12, will be by far the largest yet held. Approximately 25 countries are expected to be represented, and total space bookings in all classifications, including consumer goods, will approach the 250,000 sq ft mark. Five large exhibit halls and an outside area will be used to contain the exhibits.

In the machinery section, nine countries are so far represented, and five other countries have expressed their intention of showing products within this classification. Canadian manufacturers will have approximately half the space in this section, with a wide variety of machine tools, processing machinery, material-handling equipment, and other industrial goods. This year will see the strongest Canadian showing since the Fair was organized in 1948.

England will be the second-largest participating country, specializing in machine tools but including a large selection of other products designed to meet North American specifications. Germany is continuing the drive for export markets chiefly with machine tools and related equipment. France is also a large exhibitor in the machinery section. Other countries represented here are Austria, participating on a large scale for the first time, Scotland, Sweden, and the United States. Other countries likely to be represented in the machinery section are Australia, Denmark, Japan, Norway, and Switzerland.

Education

Statistical Quality Control

THE college of engineering, University of Colorado, will conduct a training course in statistical quality control, June 16–26.

The course will include acceptance sampling and other statistical techniques used in industry.

The course is most useful if men who are acquainted with the over-all production and inspection operations of a particular company are trained in these techniques.

Application or further information about the course can be obtained by writing John F. Wagner, 214 Kerchum, University of Colorado, Boulder, Colo.

Gaillard Seminar

JOHN Gaillard, Mem. ASME, mechanical engineer on the staff of the American Standards Association and lecturer at Columbia University, will hold his next five-day private seminar on industrial standardization from June 22 through June 26, 1953, in the Engineering Societies Building, 29 West 39th Street, New York 18, N. Y.

The Gaillard Seminars were started in 1947 upon request from companies for assistance in the organization of their standardization work and the training of their men in writing standard specifications. More than 100 organizations have been represented so far.

The June, 1953, session will consist of ten conferences, one in the morning (9:30 to 12:00) and one in the afternoon (1:30 to 4:00), Monday through Friday. At each conference a subject on the seminar program will be presented by Dr. Gaillard and then discussed around the table.

For further details and registration, write to Dr. John Gaillard, 400 West 118th Street, New York 27, N. Y.

M.I.T. Summer Courses

AMONG the many courses planned for the special summer program to be presented at the Massachusetts Institute of Technology, are listed the following: Aerodynamic measurements, fundamentals of physical metallurgy, lubrication engineering, to be given from June 16 to 26; feedback control systems, June 22–July 3; thermodynamics of equilibrium and nonequilibrium states, June 29–July 10; advanced strength of materials, product design, July 6–17; principles of textile research, July 6–31.

Further information and application forms for the special summer-program courses may be obtained from Dr. E. H. Huntress, Director of the Summer Session, Room 3-107, Massachusetts Institute of Technology, Cambridge 39, Mass.

Plastic Deformation of Metals

THE H. H. Wills Physical Laboratory and the department of adult education of the University of Bristol, in co-operation with The Institute of Physics, will be conducting a short summer school followed by a conference on The Theory of the Plastic Deformation of Metals, with special reference to creep and to fatigue, July 13–16, 1953, in Bristol. The course is similar in conception to those held in the University of Bristol on this and similar subjects; it is intended mainly for research students at universities and for members of the staffs of government and industrial laboratories. The particular aim is to see to what extent the observed phenomena can be explained in terms of present theories, and to guide future work.

The fee for the summer school, which will be on July 13–14, is £1.10.0d.; but there will be no fee for the conference.

Further particulars and forms of application, to be returned before May 31st, can be obtained either from the Director of the Department of Adult Education, The University, Bristol 8, or from the Secretary of The Institute of Physics, 47 Belgrave Square, London S.W.1.

Scholarships

FOURTEEN universities and colleges in the South, Southwest, and Middle West have accepted awards for fellowships or scholarships offered by The Atlantic Refining Company. The awards will cover the academic year beginning next September. The company stated that the awards were made for the purpose of encouraging outstanding undergraduate and graduate students in the study of techniques connected with crude-oil production.

The studies specified in the awards will be carried on in a department of geology, geophysics, or chemical, petroleum, mechanical or electrical engineering of the various institutions. Each university and college will recommend a student as the recipient of its Atlantic award on the basis of his scholastic accomplishments and promise in the department designated by the company.

The fellowships have been accepted by Washington University, St. Louis, Mo., and Rice Institute, Houston, Texas.

Scholarships have been awarded to the University of Texas, Austin; Southern Methodist University, Dallas; Texas A&M College, College Station; and Texas Technological College, Lubbock, Texas; University of Oklahoma, Norman, and Tulsa University, Tulsa, Okla.; Louisiana State University, Baton Rouge, La.; New Mexico School of Mines, Socorro, N. Mex.; Ohio State University, Columbus, Ohio; Georgia Institute of Technology, Atlanta, Ga.; Colorado School of Mines, Golden, Colo.; and St. Louis University, St. Louis, Mo.

Shell Research and Fellowship Programs

A 15 per cent increase in the Shell research and fellowship programs for 1953–1954 was announced by the Shell organization. The total cost next year will be $177,500.

Research grants, at $5000 each, are made directly to university science departments to aid them in conducting basic research in chemistry, chemical engineering, geology, mechanical engineering, metallurgy-corrosion, physics, and engineering mechanics. Schools receiving fundamental research grants in 1953–1954 are: California Institute of Technology, Carnegie Institute of Technology, University of Chicago, Harvard, Massachusetts Institute of Technology, Princeton, University of Rochester, Stanford, and Yale.

The Shell Fellowship Program is designed to help outstanding graduate students obtain advanced degrees in the fields of chemistry,

chemical engineering, geology, geophysics, mechanical engineering, petroleum-production engineering, physics, and plant science.

Shell fellows are selected by their colleges or universities. Candidates in their last year of doctorate study are given preference, but awards may be made to other graduate students. The fellows are under no obligation to Shell.

Both the fellowship and the basic research programs are administered by the Shell Fellowship Committee, made up of senior executives representing Shell Oil Company, Shell Chemical Corporation, Shell Development Company, and Shell Pipe Line Corporation.

American Brake Shoe Scholarship

THREE scholarships in mechanical engineering have been established at Northwestern University by the American Brake Shoe Company, New York, N. Y.

The scholarships will go to a member of the junior, presenior, and senior classes every spring. They will cover at least one third of the student's annual expenses. Students receiving the awards will be encouraged to do their in-plant co-operative training work at one of the Brake Shoe plants.

Candidates for the scholarships will be judged for character, personality, scholastic record, need for financial aid, and interest in general college activities.

Stevens Institute

THE first scholarships endowed by funds of the recently dissolved Steam Locomotive Research Institute will be awarded this spring to deserving sons of railroad men or deceased railroad men, who are prepared to enter Stevens Institute of Technology next fall.

Only young men of railroad families are eligible for the scholarships. To be chosen for an award, a student must, first, have the necessary preparation to enter Stevens and second, show the need for financial assistance. A number of awards will be made with sums ranging from $200 to $700, the full cost of a year's tuition.

Application for the Steam Locomotive Research Institute scholarships should be made in writing to the Director of Admissions, Stevens Institute of Technology, Hoboken, N. J.

Literature

Air Conditioning

A PROPOSED Standard on Methods of Rating and Testing Air Conditioners (16-53) which is a revision of Standard 16-R, bearing the same title, has just been released by The American Society of Refrigerating Engineers. This latest revision affects primarily the room air-conditioner portion of the Standard and is for the purpose of providing alternate testing methods in addition to the calibrated room originally specified in Standard 16-R and to which some objections had been raised. Included in the Standard are the cooling and the heating and other functions of self-contained air conditioners, room air conditioners, remote-type air conditioners, heat pumps, and oil and gas-fired air conditions.

The Methods of Rating and Testing Forced Circulation and Natural Convection Air Coolers Standard has been revised to change the method of calculating the cooling capacity from a net-total cooling effect to a gross-total cooling effect. This publication is now known as Standard 25-53 and shortly will be available for distribution.

These Standards may be obtained from ASRE Headquarters 40 W. 40th Street, New York 18, N. Y.

Brazing Filler Metal

ISSUANCE of the Specifications for Brazing Filler Metal brings the total in the series of filler-metal specifications issued to date to eight.

The Brazing Filler Metal Specifications cover every type of brazing filler metal in common use today. The 33 different classifications are divided into groups according to the principal constituents. They include classifications for aluminum-silicon; copper-phosphorus; silver; copper-gold; copper and copper-zinc; magnesium; and heat-resisting filler metals.

The Specifications, as usual, include an appendix giving helpful information for the selection of the brazing filler metal best-suited for a given application. Among the factors included are the brazing temperature range for each classification, the color of the joint obtained, recommended joint designs, and an explanation of some of the fundamental concepts of brazing which have previously been misunderstood.

Copies of the Specifications for Brazing Filler Metal can be obtained, at 40 cents each, from either American Welding Society, 33 West 39th Street, New York 18, N. Y., or the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

Industrial Dispersion

THE U. S. Department of Commerce has issued a guidebook to help communities and manufacturers select sites for new defense-supporting plants which will afford relative security from enemy attack.

Entitled "Industrial Dispersion Guidebook for Communities," the new publication is the third on the National Industrial Dispersion Program issued by the Government. The first two, published by the National Security Resources Board, explained the program. The new book, prepared by the Commerce Department's Area Development Division in co-operation with NSRB, the Office of Defense Mobilization, and the Defense Production Administration, tells how national dispersion standards may be applied to any particular metropolitan area.

Copies of "Industrial Dispersion Guidebook for Communities" may be purchased at 20 cents each from the U. S. Department of Commerce.

Council on Productivity

THE Final Report of the Anglo-American Council on Productivity, recently published, contains a general survey, the organization and meetings of the Council, work of the Council, the cost of the program, and six appendixes, which include a report on procedures, impact of the reports on industry, team reports—distribution figures, and other activities of the Council, members of the Council, and the staff.

Copies of the report may be purchased from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

Engineering Manpower

A REPORT issued by the National Society of Professional Engineers, "How to Improve the Utilization of Engineering Manpower," is based upon the results of the second survey on engineering-management problems conducted by the society's Professional Engineers Conference Board for Industry. It pools the experience of more than 495 companies employing engineers, on the subject of using engineering manpower to the best advantage.

The purpose of the research program is to assemble and publish current information on engineering-management relations for the benefit of industrial employers of engineers and the engineering profession.

The report contains two utilization checklists—one to analyze engineers' company assignments to determine if their talents are used to the best interests of both individual and company; the second to obtain the staffs' suggestions for supporting personnel assignments and other steps which will enable them to concentrate on developing ideas and creative engineering work.

Copies of this 52-page report on utilization may be obtained from the National Society of Professional Engineers, 1121 Fifteenth Street, N. W., Washington 5, D. C., at $2 for single copies.

Engineering Research

"INTERACTION of a Side Jet With a Supersonic Main Stream," Bulletin No. 35, Engineering Research Institute, University of Michigan, Ann Arbor, Mich., embodies the results of experiments conducted in 1950 in the University's Supersonic Wind Tunnel to explore the main characteristics of the flow and pressure field generated by a supersonic jet directed at 90 deg to the body into the 1.90-Mach-number tunnel stream.

This 34-page report by M. V. Morkovin, C. A. Pierce, Jr., and C. E. Craven is illustrated and may be purchased from the Institute for $1.20 a copy.

Ferromagnetism

THE Oklahoma Experiment Station has recently published Bulletin No. 83, "Ferromagnetism and the Curie Point," by B. M. Aldrich. The bulletin covers many phases of the subject such as a brief history of magnetism, magnetic classification of materials, exchange forces, theory of ferromagnetism, the Curie point, and others. It has many diagrams, tables, and curve sheets. The bulletin is sent free upon request addressed to the Oklahoma Engineering Experiment Station, Oklahoma A&M College, Stillwater, Okla.

Junior Forum

Conducted by Joseph Schmerler[1]

The Engineer—His Growth

A. C. MONTIETH, Mem. ASME, vice-president, engineer, Westinghouse Electric Corporation, Pittsburgh, Pa., speaking before a meeting of the Delaware Engineers Association in Wilmington, Del., on the professional development of young engineers made the following observation:

Professionally I have been engaged in engineering for 29 years. I like my work and I have received good counsel and pleasure in my associations with other engineers. I have enjoyed listening to the opinions of other engineers and have not hesitated to express my own.

I must admit though that this confidence disappeared when I considered this subject: "The Engineer—His Growth." Obviously, this is a complex topic of tremendous scope. It becomes even more important when we recognize, as the public frequently does not, the vital role which the engineer plays in almost all phases of our material life.

In this era of mass production the engineer is taking an ever-increasing position in the executive field. During the last decade, engineers have begun crowding the bankers and lawyers in the contest for high-level administrative posts. So successful have been their efforts that an independent survey shows that one third of the largest corporations in America—50 out of 150—are headed by graduate engineers. The records also show that 40 per cent of those taking an engineering education end up in management positions.

We see that the schools, corporations, communities, and societies have one objective: to do everything possible to help the young man rapidly attain full professional stature, provided, of course, the young man realizes that he first must accept the program with enthusiasm and devote time to it.

What are some of the characteristics a young engineer should have?

He should have his mind fixed on a definite field of endeavor but should allow some flexibility in his thinking.

He should be loyal to the company for which he works.

He must realize early in his career that interest in his job is paramount.

He must be willing to work.

He should be encouraged to be a team player.

He should have determination.

He must expect that his mistakes will be noted.

He must be encouraged to continually analyze himself on all matters but especially to be sure he understands his objectives.

He should be encouraged to accept responsibility.

He should be encouraged to be a businessman.

These points, of course, do not cover all the desirable traits but are sufficient to suggest that, in general, progress will be made if a reasonable degree of common sense is mixed with initiative.

But, before we complete this reference to the responsibilities of the individual in achieving growth, there is one other point I would like to make. I have set it aside from the others, not only because it is seemingly paradoxical, but because it is a question which everyone must face at some time in his life. And, in my opinion at least, while one answer will not necessarily assure growth, the other will certainly limit it.

Opportunity or Security

The question is "opportunity" or "security," and in this form it has received a good deal of consideration and a fair amount of discussion in the political field. Generalizations have a way of being misleading, and I think that this is no exception when we imply that there is a choice of either opportunity or security. As a matter of fact, security follows opportunity. If you doubt that statement, think of the automobile at the turn of the century, and General Motors today or the chemical industry and the du Pont organization.

So I think it is essential for the young engineer to choose opportunity if he is to make future growth possible. By this I mean, a job which is challenging and stimulating, one which will give him an opportunity to do real engineering.

But, and here comes the paradox, I would caution the young engineer to beware of impatience. And unfortunately, the engineer with the greatest potential is frequently the most impatient. In all too many cases, impatience has blinded the engineer to the real opportunities that are all around him.

So much for the individual. Now what are some of the responsibilities of others in seeing that he develops at a satisfactory pace?

Considerable attention in recent years has been directed to this problem by the Engineers' Council for Professional Development. This group has attempted to develop a program for the individual. Although through committees the Council does much work on subjects closely allied to our topic, I think we are most interested in the Committee on Professional Training which is formulating a program to bridge the first five years after graduation. The Committee firmly believes that if healthy attitudes are established during this period from then on the young engineer can put greater effort into his own development.

Developing an Engineer

To achieve this healthy development, the Committee recommended a number of actions.

In the first place, they found it essential that engineers be given the opportunity to do engineering. Now this may seem facetious, but detailed studies show that much of the work now being done by trained engineers in industry today can be done by supporting personnel. The Committee points out that this waste of engineering talent in a time of engineering shortage is not the greatest loss a company can expect unless it rectifies this situation. We must consider also that nonengineering assignments handled protestingly by older engineers adversely affect the young engineer because the attitude of the older man is important to his youthful counterpart. Further, nonengineering assignments for the young engineer can directly discourage him, and even worse, can impair his development by failing to offer the continued challenges essential to growth.

The second step, the Committee reported, in assuring that a man grows at the maximum rate, is a good training program. The transition from directed development in college to self-development in industry is not easy, and such transition becomes more difficult with every passing day. This is true because industry is becoming increasingly technical and complex. While the craftsman of former years grew up with the business, the college graduate of today steps into a strange organization at a relatively high level. He has had no opportunity to understand, through long association, the methods and operations of the concern. Industry therefore has a dual responsibility in orienting him first into the business world itself, and secondly, in giving the guidance and training so that he can start building on the foundation provided by his formal education.

Westinghouse has had some experience in company training programs, and so have others, but I cite this experience rather than that of other companies simply because I am most familiar with it. Our plan is called the Graduate Student Training Program. Its aims are to acquaint the first-year engineer with our company and the way we operate, and to find the particular niche where he can get started on his professional career. To accomplish this we have an Educational Center which serves as the main orientation base for our graduate students. From there they are sent out to the divisions so that they will be familiar with the many types of engineering jobs we have to be done. When an engineer finds a job he'd like to do, in a division that likes him, he's in business.

Now we recognize that there is no direct teaching method that can do the entire job of developing the engineer professionally. It is only through good training, proper guidance, and continuous encouragement that the graduate engineer can increase his professional stature.

Another advantage, and an even more important one, is that a good training program develops healthy attitudes.

The training course brings the engineer into contact with the best men available for training work. Such association provides an enduring beneficial influence on his behavior. He unconsciously builds fences against influences that can reduce his professional status and his individuality.

[1] Jun. ASME.

Then too, by proper training, an industry that was new to a young man a short time before employment, becomes a dynamic entity, and he feels a part of it. Consider that the young graduate has been carefully selected as potentially a key man. He reports to work determined to really wade in and build a reputation. These hopes are increased when he finds that his company is devoting the time and effort necessary to acquaint him with its policies, objectives, and procedures. He realizes that meanwhile, he is, at best, only semiproductive but the company sees fit to pay him a salary during the training period. Certainly this company must have plans for him, and he must get himself ready for the opportunities that will open to him.

The sincere employer considers high-quality training of the young engineer to be an obligation, and his professional growth a challenge. It is certainly one way to help our young engineers "do more, quicker," and, to that extent, have the effect of increasing our numbers, thus offsetting our present shortage.

In addition to a good program of training, another immediate measure employers can adopt to develop the individual is to urge younger men to continue their education. Good learning habits encourage efficient performance. Morale is kept high if the employer encourages and assists the young engineer in supplementing his college training by evening classes or guided self-study. The maturing and broadening effect is obvious.

Personal Growth Important

Now thus far, our discussion has been limited to professional growth of the young engineer. Equally, or possibly more important, is personal growth as a responsible and congenial member of the community.

During the first few years with the company, the young engineer is finding his place in the organization, attempting to understand himself, and shaping his professional attitude, setting his sights on a goal. Frequently, he is establishing his family and generally his salary is modest. Closing the gap between his experience on the campus and realities of earning a living is not an easy task. It is further complicated by the fact that the majority of engineers must build up a new social life at the same time, since there just aren't enough job opportunities in either home towns or college towns.

It seems to me that right here is an excellent place for the local engineering councils to take a hand and welcome the newcomer to the community as well as to the profession. I have attended enough local meetings to realize the excellent jobs these societies do in furthering technical knowledge, but it has always seemed to me that social events are very limited. The compatibility of professional interest of the engineering societies forms a good nucleus for advancing social activities.

The program envisioned by the ECPD embraces orientation and training, continued education, self-education, and integration into the community. This involves the individual, the employer, a local school, if present, and the engineering council or association. It is a wonderful opportunity for co-operative effort in the development of the engineer.

Actions of the ASME Executive Committee

At a Meeting at Headquarters, March 24, 1953

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on March 24, 1953. F. S. Blackall, jr., chairman, presided. In addition to Mr. Blackall, there were present: H. E. Martin, E. S. Theiss, W. F. Thompson of the Committee; E. J. Kates, assistant treasurer, and C. E. Davies, secretary. The following actions were of general interest:

Student Branches

It was reported that the Finance Committee has approved an increase of $1000 for travel expenses to Student Branch Conferences. The Finance Committee has also approved an appropriation for the distribution to each graduate who is a member of an ASME Student Branch of the pamphlet, "The Unwritten Laws of Engineering."

IIRD Custodian Fund

The committee voted to confirm its action of Jan. 21, 1953, authorizing establishment of the IIRD Dynamic Systems Committee Custodian Fund. This fund will pay expenses of foreign speakers on the 1953 Annual Meeting program of IIRD.

Welding Research Council

After reviewing the situation, the request of the Welding Research Council for $500 to support the work of the Pressure Vessel Research Committee was approved.

Interchange of Membership

The committee voted to concur in the general recommendation made at the 1952 Regional Delegates Conference that the initiation fee be waived for applicants for membership who are already members of some other founder society, or of a society with equivalent membership requirements. However, the committee authorized development of the idea with one society only on the reciprocal basis. The American Institute of Electrical Engineers was chosen as the first society with which to develop the idea.

H. R. Pearson

Regret was expressed at a communication from Harry R. Pearson, vice-president, Region VIII, announcing that he is moving to Des Moines, Iowa. This automatically makes vacant the office of vice-president, Region VIII. Section representatives from Region VIII will be asked to suggest someone to serve in Mr. Pearson's place from June, 1953, through November, 1953.

1952 Power Show

Additional payments of $380.29 have been received from the International Exposition Company due the Society in connection with the 1952 Power Show. This sum completes the total of $15,880.29. The committee authorized crediting the additional sum to the Research Reserve.

Westinghouse Gold Medal

It was reported that a check for $22,500 has been received from the Westinghouse Educational Foundation for establishing the George Westinghouse Gold Medal. This award will be administered by the ASME.

In connection with the new award, the committee approved the design of the gold medal as inspected at the Medallic Art Company by H. N. Muller, Jr., B. P. Graves, and C. E. Davies.

EUSEC Conference

Attendance of the President and the Secretary at the next Conference of Representatives from the Engineering Societies of Western Europe and the United States was authorized. This conference will be held in Paris, Sept. 7–11, 1953.

Certificates of Award

A certificate of award was granted to David L. Arm, retiring chairman, Education Committee. A certificate will also be granted to J. C. Jeffers, Jr., who will retire as chairman of the West Virginia Section at the end of 1953.

Holley Monument

The American Institute of Mining and Metallurgical Engineers and the American Society of Civil Engineers have expressed interest in the program to rehabilitate and relocate the Alexander Lyman Holley monument now in Washington Square, New York, N. Y. The Secretaries agreed that a joint commission of three, one from each society, be appointed to make necessary arrangements and to raise funds for the project. R. M. Gates was appointed as the ASME representative on the Joint Commission to rehabilitate the monument.

Appointments

The following appointments on committees and joint activities were approved: K. E. Neff, junior adviser, Professional Divisions Committee; W. M. Morley, junior adviser, Meetings Committee; L. H. Zepfler, J. R. Michel, and E. R. Kaiser, Research Committee on Low-Temperature Flue-Gas Corrosion and Deposits; M. W. Garland, PTC Committee No. 25 on Safety and Relief Valves; Frederick Bolles, ASA Sectional Committee Safety Code for Elevators, A17; and C. E. Davies, Labor Legislation Panel, Engineers Joint Council.

Engineers' Council for Professional Development Inspection Committees:

Region I—C. H. Berry, L. E. Seeley, R. G. Warner, R. G. Chapman, Walter Emerson, R. G. Sidle, Kerr Atkinson, and A. J. Burdoin.

Region II—A. G. Christie.

Region III—B. G. Elliott, L. J. Fletcher, C. A. Koepke, F. W. Marquis, G. W. Watts, F. L. Wilkinson, J. T. Rettaliata, C. M. Stanley, G. L. Tuve, D. S. Brown, E. J. Taylor, Jr., H. L. Solberg, G. A. Hawkins, D. P. Eckman, and F. D. Carvin.

Region IV—N. C. Ebaugh, E. B. Norris, F. F. Groseclose, M. J. Goglia, J. B. Jones, K. P. Hanson, V. M. Faires.

Region V—W. H. Carson, A. M. Hill, G. F. Branigan, C. W. Crawford, V. L. Doughtie, B. E. Short, J. J. King, and W. B. Preston.

Region VI—Linn Helander, H. O. Croft, W. S. Beattie, K. D. Wood, F. H. Prouty, Eric Lindahl, and N. H. Barnard.

Region VII—R. L. Daugherty, M. P. O'Brien, E. O. Bergman, F. C. Lindvall, A. L. London, S. F. Duncan, C. J. Vogt, D. M. Schwartz, B. T. McMinn, and Ralph Barnes.

The following presidential appointments were confirmed:

H. E. Mayrose to dedication of national headquarters of American Society of Tool Engineers, March 16.

C. C. Franck, and J. A. Quaid to annual meeting, American Academy of Political and Social Science, Philadelphia, Pa., April, 10–11, 1953.

E. S. Theiss to Case Diamond Jubilee Convocation on "The Challenge to Free Men in the Atomic Age," Cleveland, Ohio, April 10–11.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York, 8 West 40th Street · Chicago, 84 East Randolph Street · Detroit, 100 Farnsworth Ave. · San Francisco, 57 Post Street

Men Available[1]

Plant, Production, or Assistant General Manager, 40, 18 years' responsible experience with two firms manufacturing machinery, plate and structural products, and heavy ordnance. Cornell, ME; PE in Pa. Me-953.

Mechanical Engineer, 29, BME, June, 1947, background in design and development. Experienced in supervision of project engineers engaged in production engineering of ammunition such as shot, shell, and cases. Prefers metropolitan New York area. Me-954.

Mechanical Engineer, M.I.T. graduate, BSME, PE, 14 years' highly diversified experience electromechanical devices, instruments, machinery, process development. Desires middle-weight administrative engineering assignment, challenging opportunity. Top caliber. Me-955.

Engineering Executive, BE, master's, registered, 13 years' experience in power, processes, plant design, construction, operation, engineering simplification, economic investigations and reports, contracts and equipment purchase. Prefers Conn. Me-956.

Department Manager or Administrative Assistant, mechanical graduate, PE in Mich., major experience in research laboratory and engineering-department management. Cost-conscious and familiar with budgeting and cost-analysis and control problems. Thoroughly versed in problems of utility operations from standpoint of top management. Me-957.

Mechanical Engineer, 29, BE, 7 years' experience in home-appliance manufacturing industry, including supervision of development, design, evaluation, testing, and inspection of electromechanical devices. Available August 1, 1953. Me-958.

Mechanical Engineer, M.I.T. graduate, 3 years' experience in layout and design of plumbing, heating, ventilating, and air-conditioning systems. One year aircraft industry; one year residential building construction. Would be definite asset to consulting mechanical-engineering firm. Me-959.

Product Engineer, BSME, master's degree in analysis, machinery, stress, motion, vibrations, 10 years' experience. Development, design, testing; special purpose machinery; automatic devices. Presently employed. Seeks part and/or full time position. Me-960.

Quality-Control Engineer, BS(ME); passed parts 1 and 2 N. Y. State PE exam; familiar with statistical quality-control techniques; experienced in in-process controls and investigations. Me-961.

Engineer, 38, BSME, MS, PE in Ill.; 5 years production, development, and design; 9 years teaching engineering. Seek responsible position in production management or industrial-training program. Middle West preferred. Me-962.

Mechanical Engineer, 29, BSME, Phi Tau Sigma, 11 years' experience tooling, patents, mechanisms, machine design. Knowledge electronics, office machinery. Desires position designing automatic machinery which offers opportunities for advancement. Me-963.

Administrative Assistant, BME, 5 years with large metalworking manufacturer. Plant layout, supervisor materials handling, project engineering, technical writing, production control, contract negotiation, etc., experience. Desires greater opportunity and responsibility. Me-964.

[1] All men listed hold some form of ASME membership.

Positions Available

Mechanical-Engineering Draftsman for bituminous-coal mining company. Must be familiar with the application of machinery to mining uses. Work will consist of laying out hoists, pumping stations, fans, etc. Pa. Y-8359(*b*).

Chief Engineer, 40–50, mechanical or chemical graduate, considerable experience covering plant design, operation, and maintenance of organic fertilizer factory. Must be U. S. citizen. $11,500, plus quarters. Near East. Y-8364(*a*).

Engineers. (*a*) Industrial-relations assistant with electric-utility experience. Knowledge of Spanish or Portuguese desirable. Some travel to Latin America. $6000–$8000. (*b*) Technical writer, young, mechanical or electrical graduate with editorial experience, to prepare industrial-relations material and safety articles. $5000–$7000. New York, N. Y. Y-8365.

Mechanical or Electrical Engineer for administrative position in engineering department. Must have had work experience in the design of electromechanical products and supervisory experience in a small engineering department of an electrical manufacturing plant. $6000–$10,000. Conn. Y-8370.

Sales Manager, electrical or mechanical graduate, at least 10 years' motor-field sales experience, general sales supervision, sales-promotion, and managerial experience, to take charge of sales staff of manufacturer of fractional hp and small motors. $15,000–$20,000. Midwest. Y-8382.

General Sales Manager, minimum of 8 to 10 years' experience in industrial products, preferably with background in engine applications, compressors, etc. $18,000–$25,000. New York, N. Y. Y-8386.

Senior Mechanical Engineer, at least 10 years' design and product-engineering experience covering jigs, fixtures, molding dies, presses, and electronic heating equipment for plastic-products manufacturer. $10,000–$12,000. Long Island, N. Y. Y-8393.

Chief Industrial Engineer for a department of four time-study men, to install job evaluation, standard costs tied to budgetary control and incentives. $7000–$8000. Eastern Pa. Y-8399.

Project Engineer, 3 to 5 years' experience with either a mechanical or metallurgical degree. Must have had some board experience. Will do heat-transfer work, strength-of-materials studies, and supervise operation of moldmaking, castings. Must have good knowledge of aluminum and its alloys. $7440–$8640, plus overtime. Long Island, N. Y. Y-8412.

Product Engineer, mechanical, 4 or 5 years' experience in jig and fixture, methods study, and development, with some electronics background. Salary open. Westchester County, N. Y. Y-8415.

Production Engineer, 35–40, mechanical graduate, at least 5 years' tool, die, and production experience covering fabrication of plastic-sheeting products. $8000–$10,000. N. J. Y-8419 (*a*).

Automation-Equipment Engineer, 32–38, mechanical, design background in sheet-metal dies, jigs, fixtures, and special automatic machinery serving high-production industry. Should have been engaged at least two years in developing and improving fully automatic installations. Will conceive needs, make rough design layouts, and supervise final projects. To $10,000. East. Y-8425-D-8389.

Product Designer, at least 10 years' design experience covering surgical instruments, hypodermic needles, and injection devices. $15,000. N. Y. Y-8440.

Engineers. (*a*) Heating and air-conditioning engineer, mechanical graduate, 35–50, minimum of 5 years' experience in the design and layout, and the handling of subordinates, on heating and air-conditioning installations, for consulting engineering firm. $8000–$11,000. (*b*) Designer, mechanical graduate, 3 to 5 years' experience in air-conditioning systems. $6000–$9000. Mass. Y-8443.

Chief Engineer, mechanical graduate, 38–45, minimum of 5 to 10 years' experience on material handling, conveyers, and conveyer systems. Some knowledge of automotive equipment, to move freight through warehouses. $10,000–$12,000. New York, N. Y. Y-8452.

Industrial Engineer, industrial or mechanical graduate, 40–45, administrative, production, and cost-analysis experience covering manufacturing of heavy industrial or transportation equipment. Some traveling. $8000–$10,000. New York, N. Y. Y-8454.

Instructor or Assistant Professor in mechanical engineering, graduate, to teach production engineering and laboratory, and materials laboratory. Some industrial experience desirable. Salary open. Midwest. Y-8456.

Standards Engineer, mechanical, industrial, or electrical, 3 to 5 years' experience, preferably in industrial engineering in chemical-process industry, for standards program for maintenance, materials, and equipment in company manufacturing synthetic textiles. Some traveling. $7000–$7500. South. Y-8470.

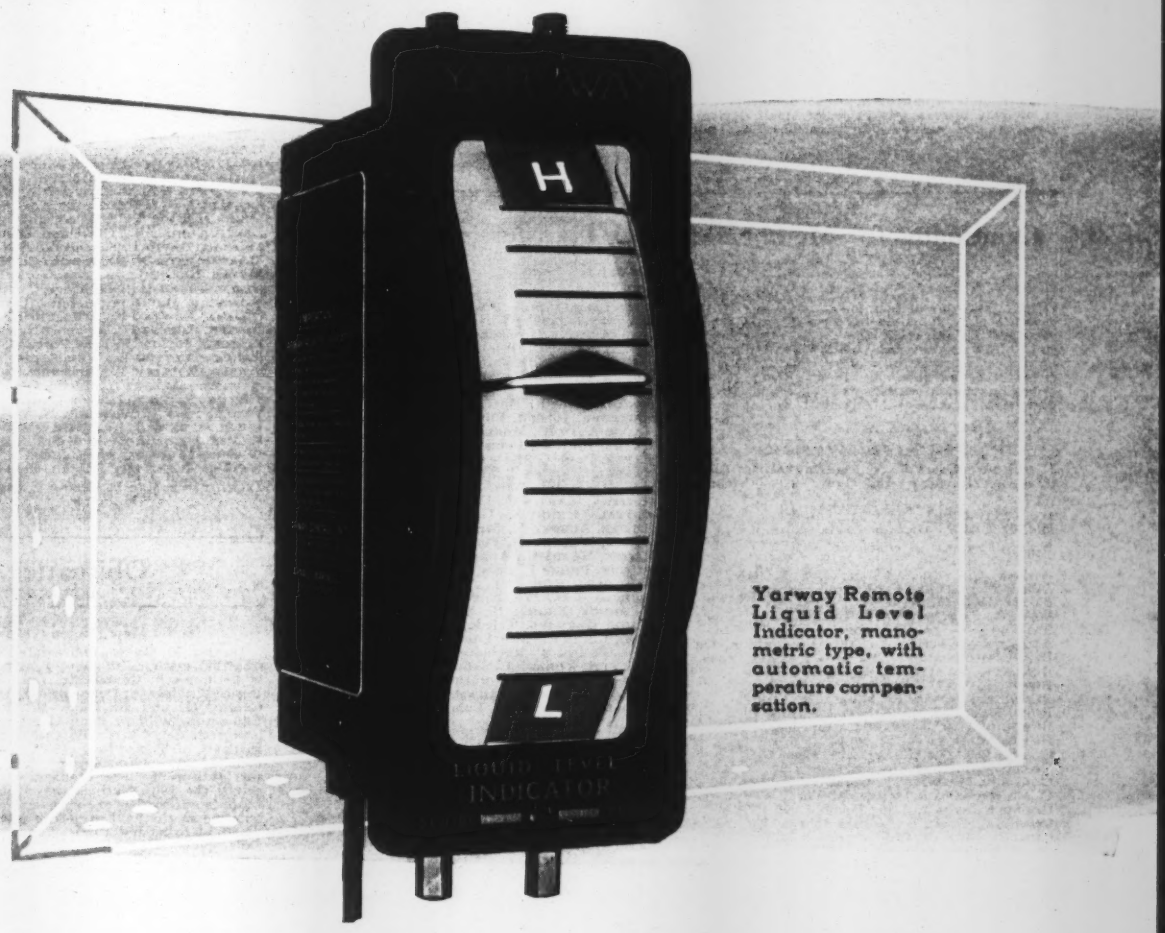
Senior Heating and Ventilating Engineer, minimum of 10 years' experience in layout of heating, ventilating, and air-conditioning systems, and general building construction. $7200–$7800. New York, N. Y. Y-8471.

Chief Engineer, 35–50, mechanical degree or equivalent with knowledge of oral Spanish. Experience with either a mining or construction company, for a large mining, concentrating, smelting, and refining company which also operates coal mines, steam-power plant, a railroad, ranches, and other facilities. Will be responsible for all the machinery, buildings, and equipment of the company in respect to design, fabrication, construction, installation, and maintenance, including roads, bridges, water supply, and approval of standards. To $15,000. Peru. Y-8475.

Mechanical Engineers, 25–35, for design, research, and development work on solid propellant

(*ASME News continued on page 440*)

What's New
IN BOILER WATER LEVEL INDICATION?



Yarway Remote Liquid Level Indicator, manometric type, with automatic temperature compensation.

IMPROVED *WIDE VISION* REMOTE LIQUID LEVEL INDICATOR

A new-type face on the Yarway Remote Liquid Level Indicator now permits side as well as head-on dial readings. This vastly improved visibility makes it possible to check boiler water levels from most any position in the control room, or wherever the Yarway Remote Indicator may be installed.

MANOMETRIC TYPE

The Yarway Indicator is a manometric type with automatic temperature compensation. Level readings are instant and accurate because the indicator is operated by the boiler water itself. The indicating mechanism is never under pressure. There are no stuffing boxes.

Over 8,000 Yarway Remote Liquid Level Indicators are successfully operating throughout industry—primarily for indicating boiler water levels, but also for many other liquid level applications, and for superheater pressure differential indication aboard ship.

For full information on Yarway Indicators, write for Yarway Bulletin WG-1823.

YARNALL-WARING COMPANY • 108 Mermaid Avenue, Philadelphia 18, Penna.

YARWAY *STEAM PLANT EQUIPMENT*

rockets and allied items. Sound fundamental background in mechanical engineering required plus initiative and ingenuity. Positions available for project engineers, assistant project engineers, and junior engineers. Relocate at company expense. Salary open. Ala. Y-8488.

Development Engineer, at least 5 years' experience in developing vending or coin machines. Knowledge of model construction. Will develop, design, and test new items in the vending-machine field for a manufacturer of vending machines. $7500–$10,000. Company will pay placement fee. Ill. T-9763.

Project Engineer, electrical or mechanical, 3 years' or more experience in project on automotive or aircraft instruments or other small devices. Knowledge of machine-shop operations. Will put gages and instruments into production after they have been developed, for a manufacturer. $7500. Company will pay placement fee. Ill. R-9722.

Design Research Engineer, mechanical, at least 2 years' experience in design and development of fluid flowmeters with automatic shutoff. Duties include research and development of fluid flowmeters with automatic shutoff valves. $7500. Company will pay placement fee. Ill. R-9723.

Design and Development Engineer, mechanical, 35–50, at least 7 years' experience in design and development of high-speed machinery. Knowledge of printing presses helpful. Will do redesigning and refining present line of printing presses for newspapers and magazines for a manufacturer. $8000–$12,000. Company will pay placement fee. Ill. R-9792.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after May 25, 1953, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement, Rt & T = Reinstatement and Transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

ALLEN, FRANK C., Denver, Colo. (Rt&T)
ARNESEN, LEIF, Rochester, N. Y.
ARNOLD, MERLYN F., Cranford, N. J. (Rt&T)
AVERETT, LENNARD C., Miami, Fla.
BAKER, JOHN H., New York, N. Y.
BASSETT, CURTISS D., Ypsilanti, Mich.
BATDORF, SAMUEL B., Verona, Pa.
BAUMEISTER, THEODORE, 3RD, Wilmington, Del.
BEAKLEY, GEORGE C., Tarleton Station, Texas
BENNETT, WILLIAM B., Richmond, Va.
BERRY, JAMES G., Ann Arbor, Mich.
BLACKARD, ERNEST C., Kingsport, Tenn.
BOYD, DAVID M., JR., Clarendon Hills, Ill.
BUONGIOVANNI, BERNARD C., Bayside, L. I., N. Y.
BUTTS, MERRILL G., Ellsville, N. Y.
CLARK, WILLIAM H., Spokane, Wash.
CONN, HUGH G., Kingston, Ont., Can.
CONNELL, MAURICE H., Coral Gables, Fla.
COOK, RICHARD R., Nitro, W. Va.
COONS, CARROL J., Long Beach, Calif.
COWGILL, HARRY B., JR., Pittsburgh, Pa.
CUMING, JOHN G., Old Greenwich, Conn.
DART, ROBERT E., Trenton, N. J.
DEFASSELLE, ROBERT J., Cleveland, Ohio
DOKO, TOSHIWO, Kanagawa-ken, Japan
DOM, HARRY A., Canton, Ohio
DOOLITTLE, JAMES H., New York, N. Y. (Rt)
DOWELL, HAROLD, L. JR., Augusta, Kan.
DREVES, FORD E., Livingston, N. J.
DUFFEY, DONN W., Defiance, Ohio
ENDER, WYMAN K., Onalaska, Wis.
FARHI, VICTOR N., Euclid, Ohio
FENDER, CHARLES C., JR., Sweeney, Texas
FONTANA, JOSEPH C., Port Arthur, Texas
FREEMAN, JACK A., Olmsted Falls, Ohio
GIMSON, ALVIN E., Philadelphia, Pa.
GOODWIN, PERCY E., Wakefield, Mass.
GOVAN, WILLIAM L., Bayside, Queens, N. Y.
GUPTA, MAKAM C., Bhadravati, Mysore, India
HAMILTON, DAVID R., Los Angeles, Calif.
HANSFORD, HOLMES N., JR., Philadelphia, Pa.
HESTER, WALTER B., S. Pasadena, Calif.
HEYDON, HAROLD R., Canton, Ohio
HOLLANDSWORTH, CHARLES J., JR., Johnstown, Pa.
HONHORST, WILLIAM J., Niagara Falls, N. Y.
HOSSELBARTH, GEORGE J., Ridgewood, N. Y.
HRTKO, DANIEL, Irvington, N. J.
HUI, CHE SHING, Hong Kong, Asia
JAHNS, WILLIAM H., San Francisco, Calif.
JANK, CLAYTON M., Hamilton, Ohio
JONES, MELVILLE A., Borger, Texas
JUSTIN, JOEL B., Havertown, Pa.
KAESTNER, PAUL T., New Canaan, Conn.
KAUFFMAN, DAVID S., Independence, Kan.
KEERAN, WILLIAM C., Chicago, Ill.
KENNEY, WALTER H., N'Eliya, Colombo, Ceylon
KOONS, HAROLD O., Willoughby, Ohio
KOPEZ, HAROLD F., Dickinson, N. Dak.
KRETSCHMAR, CHARLES G., Clifton, N. J.
KROEGER, CARROLL V., Muncie, Ind.
KRYNSKI, JOHN E., Minneapolis, Minn.
LAUGHLIN, ARVINE E., Brecksville, Ohio
LEARY, WILLIAM A., Boston, Mass.
LEAVENS, ROBERT W., Johnstown, Pa.
LEES, ALFRED, Pawtucket, R. I.
LEGGETT, GEORGE W., Amarillo, Texas
LEWIS, GERALD, Oceanside, L. I., N. Y.
LIMBURN, JAMES C., Vancouver, B. C., Can.
LOEWER, HAROLD J., Orchard Park, N. Y.
LONG, WAYNE J., Toledo, Ohio
LOWINGER, JOSEPH, Ellwood City, Pa.
MAIER, ALAN R., Mountain Lakes, N. J.
MARKS, JOHN C., Louisville, Ky.
MAYER, PAUL G., Kew Gardens Hills, L. I.
MANOLI, STEPHEN J., Chicago, Ill.
MCKEE, CARL L., San Diego, Calif.
METTZEN, MARTIN E., Houston, Texas
METCALF, HENRY K., Greenwich, Conn.
MILLER, ALBERT S., Saginaw, Mich.
MOROZ, WILLIAM J., Toronto, Ont., Can.
MOORE, HENRY C., Atlanta, Ga. (Rt&T)
MOWRY, PHILIP J., Prospect Park, Pa.
MULVIHILL, ROBERT J., Audubon, N. J.
NICHOLS, KENNETH D., Washington, D. C.
O'CONNOR, THOMAS F., Alameda, Calif.
OLSON, HARVARD, Toledo, Ohio
OTTO, LOUIS L., East Lansing, Mich.
PAGE, FRANK B., Rochester, N. Y.
PAOLETTI, ROBERT J., Santa Clara, Calif.
PEARCE, CECIL H., Moratuwa, Ceylon
PERSON, RALPH A., Milwaukee, Wis.
PHAILBUS, THEODORE, Lahore, Pakistan
PIH, HUI, Chicago, Ill.
PYLES, RUSSELL, Olean, N. Y.
RAGUSA, JOSEPH G., Depew, N. Y.
REDMAN, GEORGE L., Waukegan, Ill.
RIDLON, ERNEST S., Cape Porpoise, Me.
RIGGLEMAN, THOMAS D., Johnstown, Pa.
ROE, ARNOLD, Guayaquil, Ecuador, S. A.
ROE, DOUGLAS N., Norwalk, Calif.
RUBIN, HERBERT, Albany, Calif.
SAARLAID, HEINO, Port Arthur, Texas
SABANAS, MITCHELL, Chicago, Ill.
SCHAEFNER, ROBERT D., Lynnfield Center, Mass.
SCHULZE, KARL F., Yonkers, N. Y.
SCHULZE, OTTO R., Croton-on-Hudson, N. Y.
SCHUMACHER, DONALD R., Concord, Calif.
SHERRILL, HENRY H., JR., Burlington, N. C.
SHIPLEY, HENRY, Phoeniz, Ariz.
SHIRLEY, JAMES A., Fort Lauderdale, Fla.
SHUM, LESTER D., Brooklyn, N. Y.
SKUBIK, EMIL B., Berwyn, Ill. (Rt&T)
SOKOLSKY, KONSTANTY C., JR., Beverley, Mass.
SORACE, KENNETH J., Shaker Heights, Ohio
STARN, MARGARET E., Richmond, Calif.
SWAIN, WILLIAM W., Oakland, Calif.
SWENSON, GEORGE E., Westchester, Ill.
TENTE, ANTONIO S., Providence, R. I.
THOMPSON, JENNINGS B., Ranger, Texas
TIDBALL, ROBERT A., Callery, Pa.
TIMMONS, RAY H., Media, Pa.
TOBIN, JOHN F., Chicago, Ill.
TROST, WAYNE C., Rockford, Ill.
VALENTIN, SVEN B. O., Paris, Ont., Can.
VILLEE, GEORGE N., Johnstown, Pa.
VON MUELLER, FRANCIS, Seattle, Wash
WANG, HERBERT, Mystic, Conn.
WATSON, DONALD W., Des Moines, Iowa
WEBER, ANDREW P., San Diego, Calif.
WESTGATE, RELAND B., Savannah, Ga.
WIEDERMANN, BERNARD, San Antonio, Texas
WILLIAMS, JOHN C., JR., Plymouth Meeting, Pa.
WOOLARD, THOMAS L., Wellsville, N. Y.
WRIGHT, JACK E., East Liverpool, Ohio
WRIGHT, LESLIE S., Tambaram, South India
ZGLENICKI, CHARLES, Harrisburg, Pa.

CHANGE IN GRADING

Transfers to Member and Associate

ALLEN, STANTON, Milwaukee, Wis.
BAGBY, FREDERICK L., JR., Columbus, Ohio
BARMINGTON, RAYMOND D., Fort Collins, Colo.
BATES, JOSEPH C., JR., Sparta, Ill.
BLANDING, HOWARD C., Flushing, N. Y.
BRADT, DAVID M., New York, N. Y.
BRESSMAN, JOSEPH, Levittown, N. Y.
BUNTING, SPENCER L., Philadelphia, Pa.
BURKEY, IRWIN R., Hamburg, Pa.
CADWELL, JAMES J., Richland, Wash.
CARROLL, FRANK T., JR., Baton Rouge, La.
CLARK, ALBERT L., Tuscumbia, Ala.
COBB, DEXTER W., Drexel Hill, Pa.
COGAN, LOUIS, New York, N. Y.
COPELAND, HAROLD C., Richland, Wash.
COULTAS, ROBERT M., Schenectady, N. Y.
DAVIS, HUNT, Harrison, N. J.
FYKSE, LEWIS D., Cleveland, Ohio
GALL, GEORGE F., JR., Kenilworth, N. J.
GIVEN, DONALD M., JR., Bayside, N. Y.
HARRISON, EDWIN D., Blacksburg, Va.
JACKSON, JOHN T., New York, N. Y.
JONES, WILLIAM L., Spartanburg, S. C.
JUNAS, LADISLAV J., Maspeth, N. Y.
KAUPPINEN, TENHO S., Durham, N. H.
KLONOSKI, STEPHEN W., Torrington, Conn.
LORIG, MARVIN B., Chicago, Ill.
LYNCH, DONALD L., Cleveland, Ohio
MASSON, DAVID J., Schenectady, N. Y.
MORGAN, IVOR N. R., New York, N. Y.
MYERS, HENRY J., JR., New York, N. Y.
NEILL, FRANK H., Oak Ridge, Tenn.
NEWBERN, DAVID P., Victoria, Texas
O'GARA, EDWARD F., Arlington Heights, Ill.
PEPPER, ROBERT H., Newport News, Va.
PLESSER, JOSEPH J., New York, N. Y.
RANCK, CLAYTON E., Wilmington, Del.
STEELE, WILLIAM V., Vincennes, Ind.
STOECKEL, ALBERT L., Euclid, Ohio
TAYLOR, ROBERT G., Bala-Cynwyd, Pa.
THONE, JOHN J., Woodside, N. Y.
WILLI, ALBERT B., JR., East Detroit, Mich.
WILLIS, JOHN B., South Miami, Fla.
WILSON, JAMES F., Akron, Ohio
WOLFE, MERRITT W., Akron, Ohio

Transfer from Student Member to Junior 130

Obituaries

Daniel Moore Bates (1876–1953)

DANIEL M. BATES, industrialist and pioneer in scientific methods of factory management, died at his home in Centerville, Del., Feb. 26, 1953. Born, Wilmington, Del., April 18, 1876. Parents, George H. and Elisabeth B. (Russell) Bates. Education, William Penn Charter School, 1891; postgraduate, 1891; BS(ChE), Massachusetts Institute of Technology, 1896. Married Bertha Corson Day, 1902. Mem. ASME, 1912. He was author of "The Manager's Part," and received the 1904 National Association of Cotton Manufacturers Medal for several papers he contributed in the field of cotton fabrication. Survived by wife and three children, Mrs. Bertha Cole, New Hope, Pa.; Theodore R., Tucson, Ariz.; Mrs. Frances Muir, La Palma, Majorca, Spain; four grandchildren and a great-grandchild.

Loyd Francis Burress (1889–1953)

LOYD F. BURRESS, division superintendent, Coke Plant and Blast Furnaces, Gary (Ind.) Steel Works, Carnegie-Illinois Steel Corp., died Feb. 22, 1953. Born, Joplin, Mo., May 30, 1889. Education, BS(ME), University of Missouri, 1911. Jun. ASME, 1917; Mem. ASME, 1939.

Howard W. Cotton (1874–1952)

HOWARD W. COTTON, owner, H. W. Cotton Co., manufacturers of special machinery, Brooklyn, N. Y., died Dec. 4, 1952. Born, Trenton, N. J., May 9, 1874. Parents, Henry and Sadie Cotton. Education, high-school graduate. Married Mary Fischer, 1906. Author of several technical papers published in trade journals. Mem. ASME, 1951. Survived by wife and three children, Myrtle Mearns, Elsie Wiggins, Florence Tyler.

Dean Edward Foster (1883–1953)

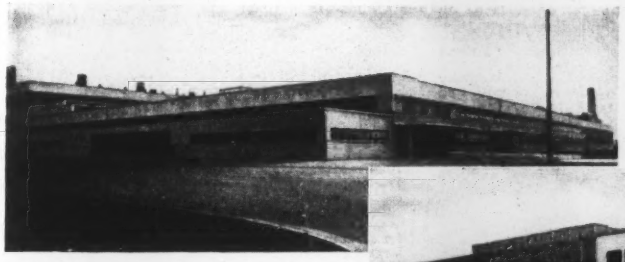
DEAN E. FOSTER, commissioner of streets and public property, The City of Tulsa, Okla., died Jan. 11, 1953. Born, Preston, Iowa, Dec. 5, 1883. Education, BS(ME), University of Wisconsin, 1906; MS(ME), 1914. He was author of many technical papers and reports for various journals and assisted in the preparation of three textbooks.

Alexander Rodgers Goldie (1873–1952?)

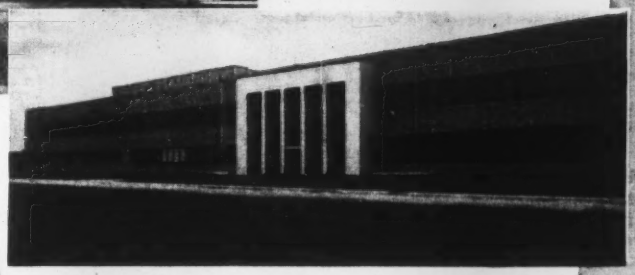
ALEXANDER R. GOLDIE, whose death was re-

(*ASME News continued on page 442*)

THE LEADERS OF INDUSTRY



Ford Motor Co. new foundry and engine plant at Cleveland, Ohio.



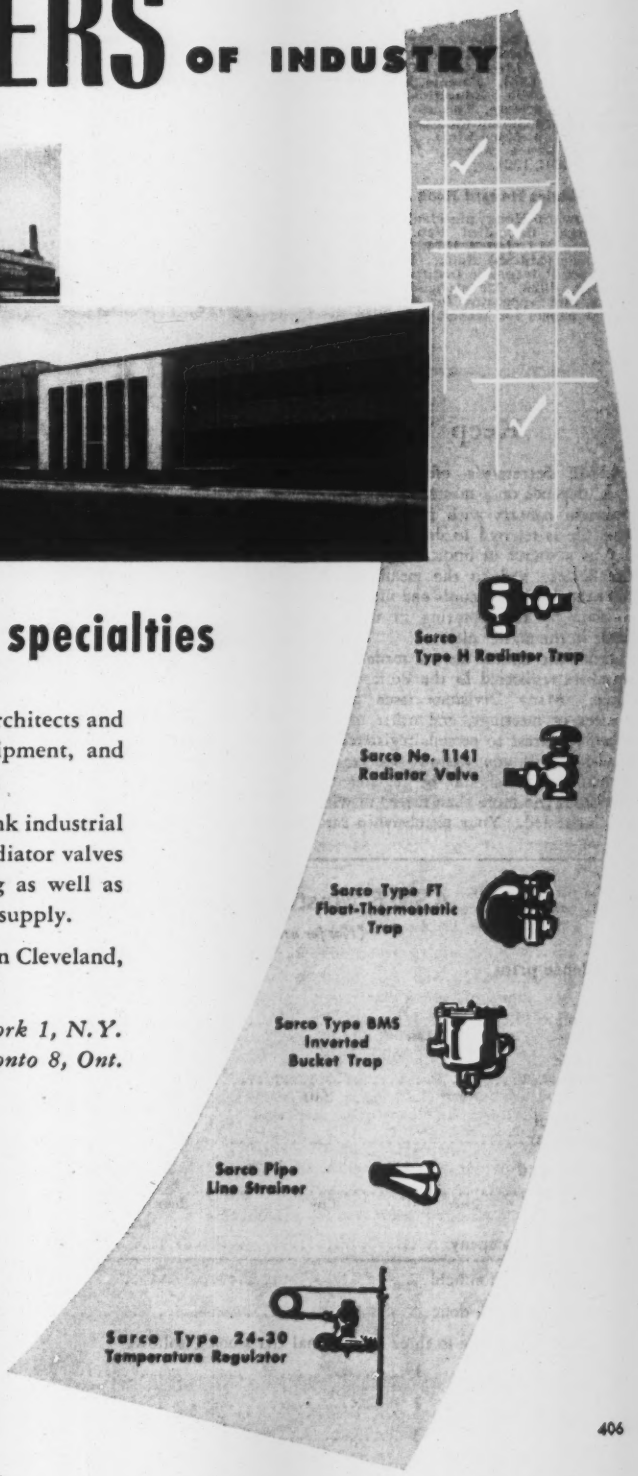
...use SARCO heating specialties

WHEN large industrial projects are planned, leading architects and engineers design the buildings and select the equipment, and many top executives must approve the specifications.

Sarco is proud to be listed in so many of these top rank industrial specifications, covering steam traps of several types, radiator valves and strainers for space heating and air conditioning as well as temperature controls for process work and hot water supply.

For example, at Ford Motor Company's new plants in Cleveland, Sarco Specialties are installed throughout.

Sarco Company, Inc. Empire State Bldg., New York 1, N.Y. Branches in principal cities. Sarco Canada Ltd., Toronto 8, Ont.


Sarco Type H Radiator Trap
Sarco No. 1141 Radiator Valve
Sarco Type FT Float-Thermostatic Trap
Sarco Type BMS Inverted Bucket Trap
Sarco Pipe Line Strainer
Sarco Type 24-30 Temperature Regulator

406

A FEW OF THE WORLD LEADERS WHO USE SARCO PRODUCTS IN THEIR NEW PROJECTS ARE:

U.S. STEEL CO.	Sarco	✓
WESTERN ELECTRIC CO.	Sarco	✓
FORD MOTOR CO.	Sarco	✓
BETHLEHEM STEEL CORP.	Sarco	✓
PRATT & WHITNEY AIRCRAFT	Sarco	✓
ALUMINUM CO. OF AMERICA	Sarco	✓

SARCO saves steam

sarco quality assures satisfaction

cently reported to the Society, was chairman of board, The Babcock & Wilcox Co., Goldie-McCulloch Co., Ltd., Galt, Ont., Can. Born, Galt, June 4, 1873. Parents, John and Margaret (Rodgers) Goldie. Education, graduate, school of practical science, Toronto University, 1893. Married Nora Gibson (deceased); children, John G., A. Gibson, Mary McD., Margaret E. Married 2nd, Grace Wilson. Jun. ASME, 1902; Mem. ASME, 1921.

Charles Howard Hook (1874–1953)

C. HOWARD HOOK, president Hook and Miller, Pittsburgh, Pa., died Feb. 9, 1953. Born, Baltimore, Md., Jan. 3, 1874. Parents, Jacob W. and Annie (Milcah) Hook. Education, 2 years, Baltimore Polytechnic Institute. Married Ruth McAbee, 1928. He designed and developed boilers and apparatus for heating and wrote several papers for technical journals describing these developments. Mem. ASME, 1922. He was an honorary member of the British Royal Society of Mechanical Engineers. Survived by wife and son, C. Howard, Jr., Edgewood, Pa.

John Hunter (1866–1953)

JOHN HUNTER, retired consulting engineer, specializing in power-plant work, smoke abatement, and an expert witness in Court cases, of St. Louis, Mo., died Feb. 5, 1953, at his home in Winter Park, Fla. Born, Girvan, Scotland, Aug. 11, 1866. Parents, John and Elizabeth (Templeton) Hunter. Education, Ayr Academy, Scotland; Hawthorne Academy, London, England; hon. ME, Stevens Institute of Technology, 1933. Naturalized U. S. citizen, Jersey City, N. J., 1890. Married Minnie L. Templeton, 1899; children, John (deceased). Arthur T. Author of many technical papers which were presented before engineering societies and colleges. Received three medals for service in the Spanish-American War. Mem. ASME, 1909; Fellow ASME, 1939. He served the Society as chairman, Ethics Committee; Manager, 1914–1916; vice-president, 1917–1918; member, Executive Committee, Florida Section. He was on the Executive Committee, Uniform Boiler Law Society, Prime Movers Committee, NELA; Fellow, Florida Engineering Society; and past-president, Engineers (Club) of St. Louis (Mo.). Survived by wife and son, Arthur T., Mem. ASME; and granddaughter, Leeanna.

Samuel Koffsky (1902–1953)

SAMUEL KOFFSKY, chief engineer, Simmons Machine Tool Corp., Albany, N. Y., died Jan. 15, 1953. Born, Kiev, Russia, Oct. 17, 1902. Parents, Many and Eva (Iskowitz) Koffsky. Education, CE, Rensselaer Polytechnic Institute, 1923. Married Nancy Bittman 1929; children, Dorice Jeane, Robert Michael. He was a frequent contributor to technical journals and often lectured before engineering societies. During World War II he designed a 36-ft circular boring mill for machining the forged-steel turret on which the large guns of a battleship swivel. Mem. ASME, 1942.

Leopold H. Lipke (1884–1951?)

LEOPOLD H. LIPKE, whose death was recently reported to the Society, was the owner of Lipke Tool Works, Newark, N. J. Born, Tauroggen, Russia, Nov. 20, 1884. Education, 2 years, high school; completed the mechanical-engineering course, ICS. Naturalized U. S. citizen, New York, N. Y., Nov. 12, 1912. Assoc. Mem. ASME, 1919; Mem. ASME, 1935.

Roderick MacKenzie Mitchell (1913–1953)

RODERICK M. MITCHELL, mechanical engineer, F. L. Smidth and Co., New York, N. Y., died Jan. 21, 1953. Born, New York, N. Y., Oct. 14, 1913. Parents, James A. and Catherine (MacKenzie) Mitchell. Education, BS, Polytechnic Institute of Brooklyn, 1943; ME, Columbia University, 1946. Married Mary Michie, 1936. Jun. ASME, 1946. Survived by wife, his mother, a sister, Isabelle Duthie; and a brother, James A.

James Hajimo Otani (1924–1952)

JAMES H. OTANI, mechanical draftsman, Allen and Garcia, Chicago, Ill., died Nov. 12, 1952. Born, Winters, Calif., Jan. 25, 1924. Parents, Shozaburo and Tsurue Otani. Education, BSE, University of Michigan, 1948. Jun. ASME, 1948. Survived by parents and three sisters, Tuney, Mrs. Tomico Honda, Mrs. Yuico Hoshizaki.

Wesley William Schettler (1894–1952)

W. W. SCHETTLER, consulting engineer, Fairbanks, Morse & Co., Beloit, Wis., died March 1, 1952. Born, Beaver Dam, Wis., March 2, 1894. Education, high-school graduate, ICS. Mem. ASME, 1944. He served the Society as a member of PTC Committee No. 17 on Internal-Combustion Engines.

Thomas Clayton Shortt (1888–1951)

T. C. SHORTT, whose death occurred June 22, 1951, according to a report recently received by the Society, was chief mechanical engineer, The New York, Chicago and St. Louis Railroad Co., Cleveland, Ohio. Born, Crewe, Va., Dec. 9, 1888. Education, high-school graduate, 1905. Mem. ASME, 1947.

Howard Wells Smith (1870–1953)

HOWARD W. SMITH, chief engineer, Aetna Standard Engineering Co., Elwood City and Pittsburgh, Pa., died Feb. 3, 1953. Born, Elwood City, Pa., Oct. 29, 1870. Education, ME Stevens Institute of Technology, 1891. Jun. ASME, 1898; Mem. ASME, 1918. Survived by two sons, Frederic M. and Walter K., and a granddaughter.

John Vandenberg (1898–1952)

JOHN VANDENBERG, chief engineer, General Tire and Rubber Co., Wabash Division, Wabash, Ind., died Dec. 23, 1952. Born, Greylingstadt, Transvaal, South Africa, Feb. 8, 1898. Education, electrical and mechanical-engineering Candidate II, Technical University, Delft, Holland, 1921. Mem. ASME, 1952.

Arthur Jason Woodward (1884–1952?)

ARTHUR J. WOODWARD, whose death was recently reported to the Society, was division engineer of General Electric Company's Locomotive Engineering Division. He was retired in 1949 after having been with GE for 41 years. Born, Lancaster, N. H., Jan. 8, 1884. Education, BS, University of New Hampshire, 1907. Mem. ASME, 1931.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult reverse side of card for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting your address, business connection, and Professional Divisions enrollment is printed on this page. Please use it to keep the master file up to date.

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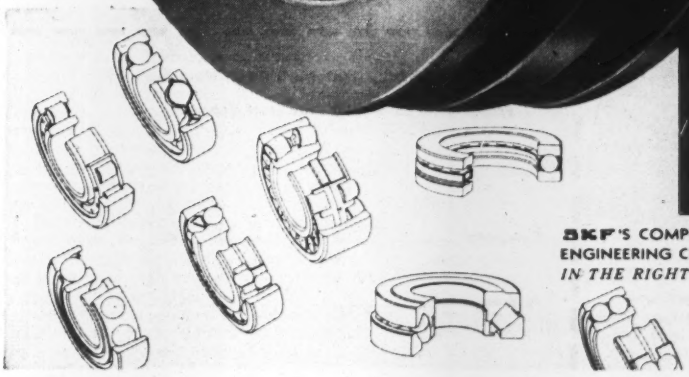

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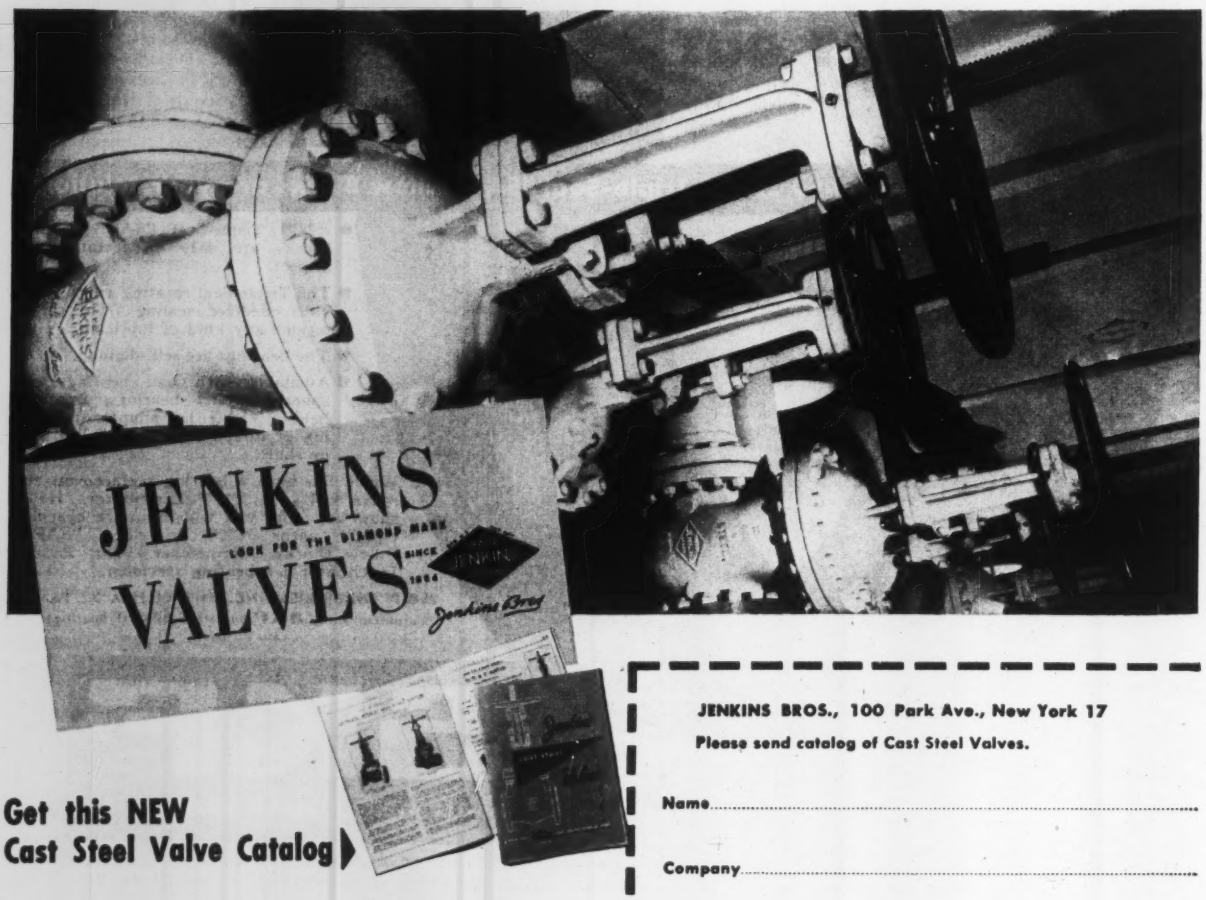

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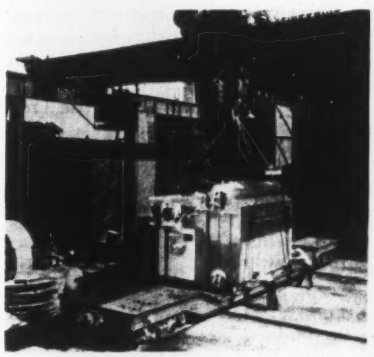
Available literature or information may be secured by writing direct to the manufacturer. Please mention MECHANICAL ENGINEERING.

NEW EQUIPMENT

Package Boiler

A new line of standardized, shop-assembled water-tube boilers is now being offered by Combustion Engineering, Inc., 210 Madison Ave., New York 16, N. Y. It is known as the C-E Package Boiler, Type VP, and is designed to meet the demand for standardized boilers operating in the medium pressure range, up to 250 psig, and for steam capacities ranging from 4000 to 30,000 lb per hr.

The design of the VP Boiler is based on the two-drum, vertical-bent-tube arrangement with a water-cooled furnace in front of the convection surface. In this new unit there is a higher ratio of furnace-wall cooling to furnace volume than in any other boiler of its size and type, assuring rapid and efficient heat absorption, and lower gas temperatures entering the convection bank, according to the manufacturer.



The boiler is designed for pressure firing of oil or gas either alone or in combination. It is completely shop-assembled, ready for shipment as a unit with firing equipment, setting, forced-draft fan, and automatic control. For oil firing, steam-assisted mechanical-atomizing burners are used; ring-type burners are furnished for gas firing. Either type of burner may be added to the air register at any time. Oil pump and heater sets are included with oil burners as standard equipment.

The VP boiler uses a centrifugal-type forced-draft fan. The manufacturer states that, since this fan supplies air to the furnace at a pressure high enough to overcome the draft loss through the unit, neither a high stack nor an induced-draft fan is required. The omission of the induced-draft fan results in a reduction of noise and eliminates maintenance required by such a fan.

A complete automatic control system is supplied as standard equipment with the VP Boiler. It adjusts the air and fuel supply in proper proportion to the needs of fluctuating loads. It also provides protection from flame failure, excessively high steam pressure, and low water level.

The VP Boiler is completely shop-assembled, and can be skidded or lifted from a railroad car or truck onto a simple foundation, such as a concrete slab or level floor. Lifting lugs are provided so that it may readily be unloaded and handled by a crane.

Remote Signal Units

A new Panalarm Adapter Unit, which permits remotely located visual trouble signals to operate as part of a common, plant-wide audio-visual annunciator system, has been announced by Panalarm Products, Inc., Chicago, 40, Ill.

For the remote visual signals, either individual back-lighted, illuminated nameplate units or bullseye lamps are furnished. They may be used for scattered locations on panelboards or operating locations in the plant. Bullseye lamps may also be used with separate "on-off" lights to form a three-light control station. All signals connect to a common horn or bell which must be acknowledged by the operator when an "off-normal" condition develops. All moving parts and contacts are enclosed in hermetically sealed plug-in units which are corrosion-proof and suitable for Class I, Division 2 locations. Additional signals may be added to the system by inserting plug-in units into chassis receptacles.

The Panalarm Adapter cabinet is prewired for all standard audio-visual sequences. They may be interchanged in the field by terminal connections. Adapter cabinets are furnished for any desired number of signals, and operate from any type of remote contact device. Further information is provided in Bulletin 3-C, available upon request to Panalarm Products, Inc., 6312 North Broadway, Chicago 40, Ill.

Grating Selector

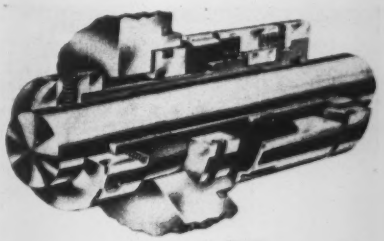
The A. O. Smith Corp. Safety Grating Div. has made available a safety grating selector which with a simple setting enables the user to choose a grating for a specific load-span condition.

The selector also will indicate the deflection of grating selected under a given load-span condition. In addition to this the A. O. Smith selector shows a complete table of panel widths in stock sizes as well as a complete range of weights of all A. O. Smith safety grating.

The device, which operates similar to a slide-rule, places at the user's finger tips the complete engineering data required for most installation with A. O. Smith safety grating. Available from A. O. Smith Corp., 3533 N. 27th St., Milwaukee, Wis.

Heavy-Duty Mechanical Seal

A heavy-duty mechanical seal which will withstand pressures up to 1000 psi is now being offered by the Crane Packing Co. of Chicago, Ill. Known as the Type 8-B Shaft Seal, it is designed for applications where ruggedness to withstand high pressures is an important factor.



A packaged unit, the Type 8-B Shaft Seal is factory inspected and furnished preassembled on a sleeve for ready installation. When used with split-case pumps it is not necessary to lift the upper half of the casing to install or remove the seal. Incorporating a rotating sealing washer and a "floating" stationary seat, balance is accomplished by lowering the washer face to a point where stuffing box pressure is not exerted against the sealing area. Mating faces of the washer and seat are precision-lapped to 0.0000232 in.

The rotating assembly consists of a retainer positively driven by the sleeve, with the washer driven from dents in the retainer. The assembly is held in contact with the lapped face of the seat by means of multiple springs equally spaced around the sleeve at the back of the retainer. O-rings provide sealing between sleeve and shaft and also between washer and sleeve. Another O-ring is used between the stationary seat and end plate as a cushioning to prevent stresses on the highly lapped seat face. For further information write to the Crane Packing Co., Dept. M-16, 1800 West Cuyler Ave., Chicago 13, Ill.

Vibration Exciter

What is said to be the largest general-purpose vibration generator ever built has been announced by the MB Mfg. Co., Inc., New Haven, Conn. This shaker is of the electromagnetic type, and rated by the manufacturer at 10,000 lb force output. Supplied with conservatively rated rotating power supply and equipped with forced-air cooling, the shaker is claimed to have the capacity for continuous duty at this output.

According to the specifications for this Model C-100 Exciter, the shaker table is supported on specially designed forged steel flexures which are said to insure straight-line motion and no resonances in the equipment's operating range of 5 to 500 cps. The manufacturer states flexure stiffness permits

DOW CORNING SILICONES

give motors more muscles

Triple production; cut tool cost over $200 a month

OPTIMUM cutting speed of the 6-32 taps in the 4-spindle drill press operated by the Allen-Stevens Corp., contract die casters of Jamaica, L. I., New York City, is in the range of 1800 rpm. In an automatic feed machine, that spindle speed means about 1450 cycles, or 2900 full reverses per hour.

That many reverses overheated the 1 hp Class A insulated drive motor so badly that it had to be shut down a total of 2 hours out of every 8. To keep the machine operating 8 hours a day, spindle speed had to be reduced to 655 rpm—resulting in tap breakage averaging $10 a day.

Allen-Stevens got themselves out of the dilemma by rewinding the motor with Class H insulation made with Dow Corning silicones. Spindle speed was immediately returned to optimum, and tap breakage stopped. Production has since tripled. Lost time has been eliminated entirely.

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. . . tells how Class H insulation made with Dow Corning Silicones is saving American industry millions of dollars a year. See how Silicone (Class H) Insulation can be used to make motors, transformers and solenoids last 10 to 100 times as long as they ever did before.

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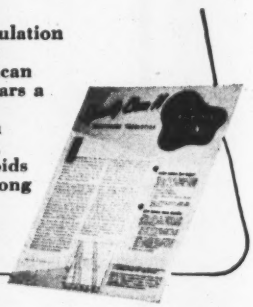

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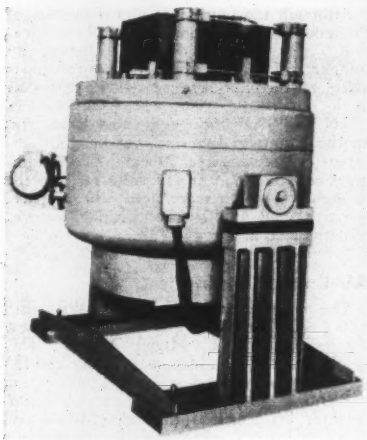
placing heavy loads on table without sacrificing a large portion of available stroke of $^1/_2$ in. It is further pointed out that the basic design of this flexure has seen service in a smaller MB Exciter for over 10 months without any shut-down time. Trunnion supports have built-in vibration isolators and permit operation in any position from horizontal to vertical.



As reported, the control panel has completely interlocking controls to prevent mis-starting or mis-operation of the equipment. Controls are provided for force and frequency; also various selector switches for the three alternators supplying the exciter's driver coil. The power supply, in addition to three alternators of pure wave form includes 50 hp a-c motor, d-c generator, d-c field exciter, and d-c motor. Volt-ampere ratings of all alternators are sufficient for full power without need for power factor correction in the control cabinet.

The manufacturer states that this new equipment with its increased power should increase the scope of vibration testing performed to military specification as well as industrial requirements.

Toggle Switches

Two new series of toggle switches that conform to AN (Army-Navy Aeronautical) and JAN (joint Army-Navy) specifications are announced by the Micro division o Minneapolis-Honeywell Regulator Co., Free port, Ill.

The switches, in addition to meeting specifications, have riveted solid silver contacts to prevent loosening and provide maximum conductivity and heat dissipation, and a copper moving contact carrier for maximum conductivity and minimum temperature rise. Momentary versions are built without return springs, eliminating a source of early failure.

One of the series, HTS, consists of nine single-pole toggle switches with either maintained or momentary contact position variations. They are bushing-mounted and a packet of fittings for mounting is included with each switch. This series has a sealed toggle lever to prevent foreign matter from entering the switch case through the toggle bushing. Either screw or solder type terminals may be supplied in all but one of the nine switches.

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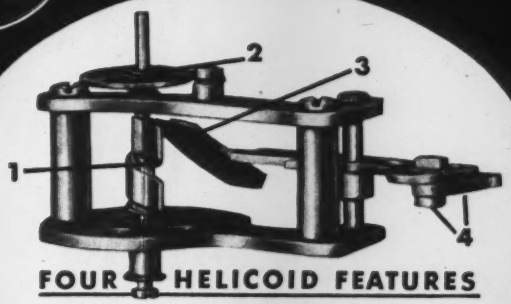

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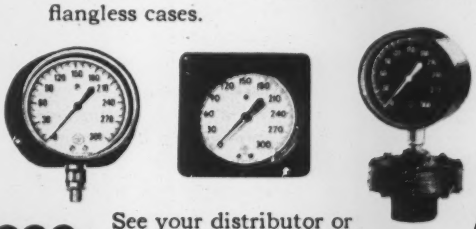

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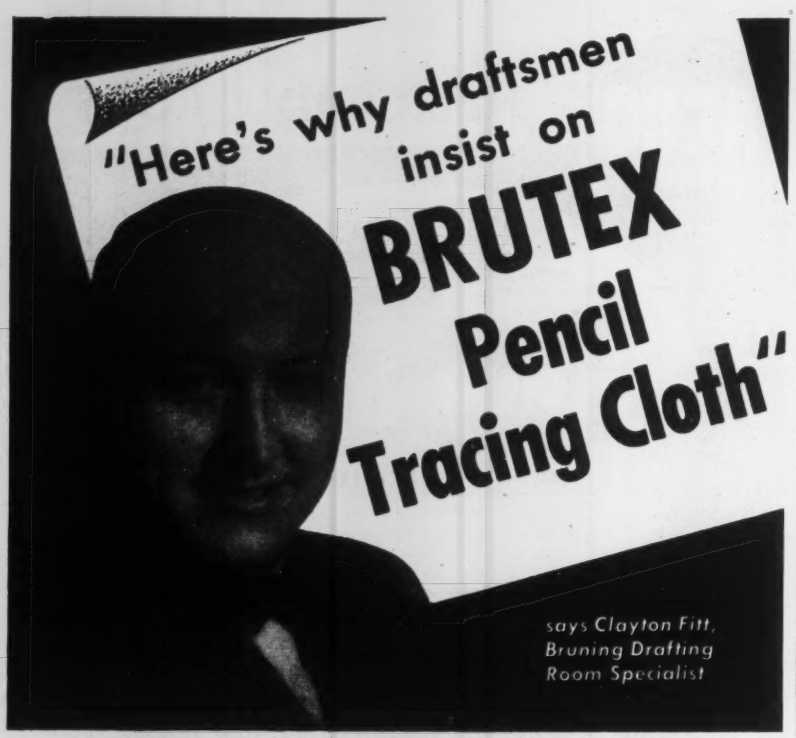

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

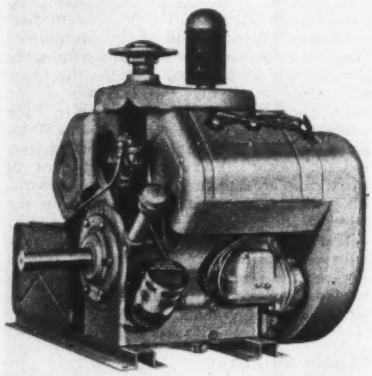
AN and JAN ratings for the IITS series are: on the maintained contact versions, 20 amperes resistive load at 30 volts d-c, 15 amperes resistive load at 125 volts a-c, and on the momentary contact version, 15 amperes resistive load at 30 volts d-c, and 125 volts a-c. The other series, 31TS, includes eight three-hold mounting type single-pole toggle switches with either maintained or momentary contact position.

Although the placement and diameters of the mounting holes confirm to AN specifications, the switch body is substantially smaller and lighter in weight than the maximum specified. They are sealed at the ball of the bat handle.

AN and JAN ratings for this series are: on the maintained contact versions, 40 amperes resistive load at 30 volts d-c, 20 amperes resistive load at 115 volts a-c; on the momentary contact versions, 30 amperes resistive load at 30 volts d-c, 20 amperes resistive load at 115 volts a-c.

Air-Cooled Engine

The most recent addition to the Wisconsin heavy-duty air-cooled engine line is the new 4-cylinder, V-type Model VG4D. This engine has a $3^1/_2$-in. bore, 4-in. stroke and 154 cu in. displacement, developing a peak rating of 36 hp at 2200 rpm, according to the manufacturer, Wisconsin Motor Corp., Milwaukee, Wis.



The Model VG4D, it is claimed, is an exceptionally smooth-running, even-firing engine, designed to provide the power needed for operating equipment within a 25 to 36 hp range. All of the features found in Wisconsin Engines are a part of the new VG4D, according to the manufacturer. These include tapered roller main bearings, dynamically balanced forged crankshaft, mirror finish on crank pins, Stellite-faced exhaust valves, valve seat inserts and honed cylinders.

In addition, valve rotators of the positive type are furnished on the exhaust valves as standard equipment.

Cooling is obtained from a large fan cast in the flywheel. When specified, these engines may be equipped to operate on kerosene, fuel oil, or natural gas.

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NEW EQUIPMENT
BUSINESS NOTES
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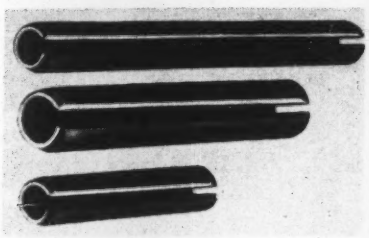
Spring-Pin Fastener

A new division has been set up by Standard Pressed Steel Co., Jenkintown, Pa., to manufacture and sell a new SPS product—a self-locking, spring-pin fastener. The fastener, called the Sel-Lok spring pin, replaces tapered, grooved, and dowel pins in all kinds of assemblies. Its advantages are said to be that it is vibration proof, absorbs shock, is easy to insert and remove, and eliminates expensive reaming operations.



SPS set up the new division after buying the production machinery, inventory, patents pending, and other assets of the Self Lock Fastener Corp. from the Rafter Machine Co., of Belleville, N. J., early this year. The machinery was moved to SPS in Jenkintown and set up in a production area in a new part of the plant where a $10,000,000 expansion program is nearing completion. General manager of the new SPS division is James F. Regan, who was vice president of the Self Lock Fastener Corp.

The Sel-Lok spring pin, which is heat treated, is a stock item in standard and light-duty wall thicknesses, in diameters from one-sixteenth of an inch to half-inch and in a wide variety of lengths. Heavy-duty pins are a special.

Pins can be had in carbon steel and in corrosion-resistant steel and, as specials, in copper-based and aluminum-based alloys. Plating available includes zinc and cadmium. A four-page bulletin which can be had from SPS describes the pins and their uses. They can be used as hinge pins, clevis pins, and cotter pins.

4000-Ton Press

A mechanical press of new design with a pressure capacity of 4000 tons, reported to be the largest ever built, has been put on production of side rails for motor vehicle chassis frames at Midland Steel Products Co., Cleveland, Ohio. Frames of this size are required by army vehicles, trucks, trailers, and buses.

With this single-action press, made by the Hamilton Works of Baldwin-Lima-Hamilton Corp., Hamilton, Ohio, side rails up to 600 lb in weight are being formed in $^3/_8$-in. steel stock. This operation produces two 90-deg, contoured bends totalling more than 50 ft in length in the blank. Principal feature of the new press is its ability to make the heaviest side rails without camber or "bow." This is accomplished by a combination of additional weight and novel design that provides a "negative deflection" in the bed and slide. At the rated load capacity of the press there is no relative deflection of the bed and slide. Consequently the formed side rail is straight within extremely close tolerances.

Although the frame is the conventional four-piece construction, the tie rods are stressed

INSTANT ICE MACHINES

WINSMITH speed reducers

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Centered in the drive mechanism powering the stainless steel blades which flake the ice, is a Winsmith Speed Reducer, Worm Gear Model 3 1/2 B, with an input speed of 2150 rpm and an output speed of 59½ rpm. "Chosen for adaptability, sound engineering design and construction . . . we have found it rugged and dependable in every way," says Liquid Freeze Corporation.

Reasons such as these have led manufacturers to look to Winsmith when they are looking for speed reducers. With fully standardized differential, worm gear, helical gear and worm-helical units — the Winsmith line is the most complete within its range of 1/100 to 85 hp and 1.1:1 to 50,000:1 reduction ratios.

Request catalog 148 for details.

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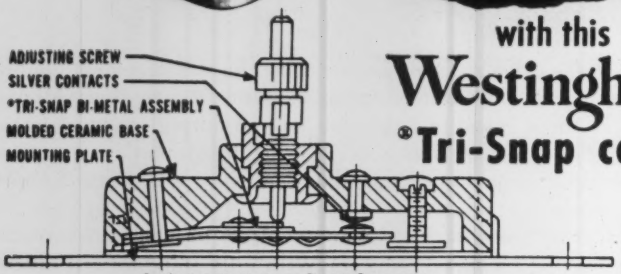

Product of Westinghouse Electric Corporation, Meadville, Pennsylvania

Westinghouse Tri-Snap® thermostats in butter warmer compartments of household refrigerators permit storing butter at a temperature higher than that of the food storage compartment. Thus a housewife can select a butter temperature that assures her the spreading consistency she desires. The snap action, quick make-quick break, is largely dependent upon precise Chace Thermostatic Bimetal.

The butter compartment is warmed by a molded wire resistor under the box. The crimping of the outer edges of the slotted bimetal element shortens the over-all length, placing the center section under compression. As the bimetal deflects due to the rise and fall of ambient temperature, the "oil-can" effect of the distorted center causes a sharp make-and-break contact with the resistor. Opening the gap between contacts lengthens the "off" period, hence the spreading consistency may be controlled to the queen's taste.

Chace engineers, recognized authorities on temperature responsive devices invite you to consult with them before designing your new temperature actuated control. Our 29 types of thermostatic bimetal are available in strips, coils, random long lengths and welded or brazed sub-assemblies. Write for our 32-page booklet "Successful Applications of Chace Thermostatic Bimetal."

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.

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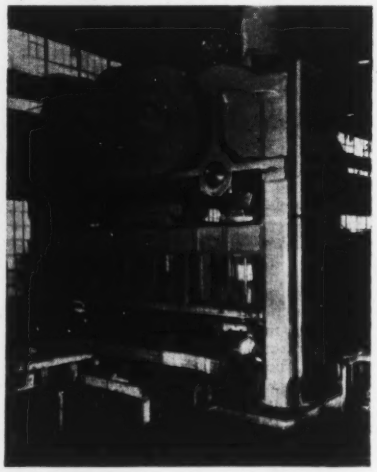
cold to the precise predetermined maximum safe working capacity of the press by hydraulic jacks instead of by the usual method of heating and shrinking them. The frame is thus virtually a solid unit until the work load exceeds the stress in the rods. Overloads elongate the rods slightly, thus protecting the vital frame members against critical deflections.



Bed, slide, and arch are each in two pieces to facilitate manufacture, shipment, and erection. They are held together on the front-to-back center plane by heated and shrunk rods. Because of the size of the rods and the amount they can be stressed, each of these members can be considered as being a solid one-piece unit.

Another important feature of the press is the provision of means for preventing distortion of the side rail during ejection from the die, including the prevention of the occasional bending and breaking of die pins. This is accomplished by the use of six 42-in.-diameter air cushions which operate as a single unit. The cushions are linked together in such manner that the six operating valves are controlled by one pilot valve and the cushions always function as one. Air cushions were specified because their stripping power is always equal to their drawing power, in contrast with hydraulic operation. They provide 415 tons pad pressure with 100-psi air.

When the cushions are close to bottom stroke, the little air remaining in them is exhausted and they stay down until the slide reaches a predetermined point on the up stroke. Then the pilot valve closes the operating valves, air is bled back into the six cushions, and the pressure pad is returned to its top position. There can be no upward creep during the dwell period on bottom because the air is at atmospheric pressure and the cushions are "dead." On the return stroke no cushion can lag behind the others, and the pressure pad cannot tilt because each cushion exerts exactly the same force on it. Consequently all possibility of distorting the side rail during ejection from the die is eliminated.

The new Hamilton side rail press has an overall height of 44 ft with topmost point 30 ft above the floor. Clear space between up-

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BUSINESS NOTES
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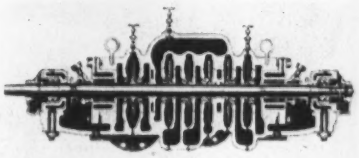
rights and gibs is 320 in. It weighs 1,800,000 lb. Stroke of the slide is 22 in., adjustment 12 in., and shut height of bed is 40 in. A 150-hp motor is used for drive and 25-hp motor for slide adjustment. Although the new press will be used normally for the largest and heaviest side rails for Army vehicles, trucks, trailers, and buses, it may also be used to form smaller side rails or other parts in pairs when desired.

Centrifugal Pump

Illustrated is the Pennsylvania six-stage Thrustfre Centrifugal Pump, typical of the Pennsylvania high-speed, high-pressure centrifugal pumps, which are manufactured in five, six, and seven stages, with capacities to 1300 gpm and heads of 1200 psig, in $2\frac{1}{2}$-, 3-, 4-, and 5-in. sizes, made by the Pennsylvania Pump & Compressor Co., Easton, Pa.



Visible from the drawing is the double suction design of the first impeller, suiting the pumps for handling hot water with low net positive suction head. The stuffing boxes are subject to low pressures only: suction pressure at first stage, and first-stage pressure on the other side of the pump.

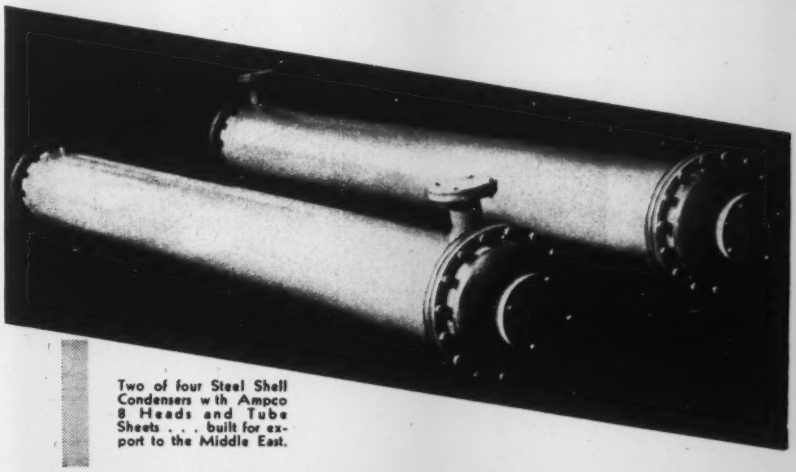
Controlled Solution Feeder

Improved processing through automatic control of chemical feeders is described in a new engineering data sheet, AED 000-10 available on request from The Foxboro Co., Foxboro, Mass. Designed for application to the Lapp Pulsafeeder Pump, the instrumentation permits the automatic feeding of treating chemicals either to maintain uniform concentrations or to correct variations of pH in any continuous process.

The Pulsafeeder Pump is operated by a constant speed electric motor, and is controlled through a pneumatic cylinder which varies the piston stroke length to change the feed rate. This cylinder is automatically positioned by a Foxboro Pneumatic Transmitter or a Foxboro Dynalog Controller, depending upon whether chemicals are to be proportioned to flow or added to control the pH of the fluid. Separate sections of the four-page illustrated folder describe feeder control in relation to flow rate; changing the feed rate by ratio-set mechanism; range of ratio adjustment; and control of pH under conditions of wide and narrow flow variations.

ONE BANNER
under which all may serve

Specialists.....



Two of four Steel Shell Condensers with Ampco Heads and Tube Sheets . . . built for export to the Middle East.

in ENGINEERING PARTICULAR APPLICATIONS to suit special needs

. . . Yes, DOWNINGTOWN solicits your inquiry for Heat Transfer Equipment fabricated of Aluminum, Inconel, Nickel, Phosphor and Aluminum Bronze, Copper, Stainless, Monel, Silicon Bronze and various grades of Carbon Steel.

Design and construction will meet requirements of ASME Code or other agency specified by customer. Equipment of our design is sold on a guaranteed performance basis or we will fabricate to customer's drawings. Modern facilities available for radiographing, stress relieving and heat treating, where required. Remember: "Your Needs are Our Specialty!"

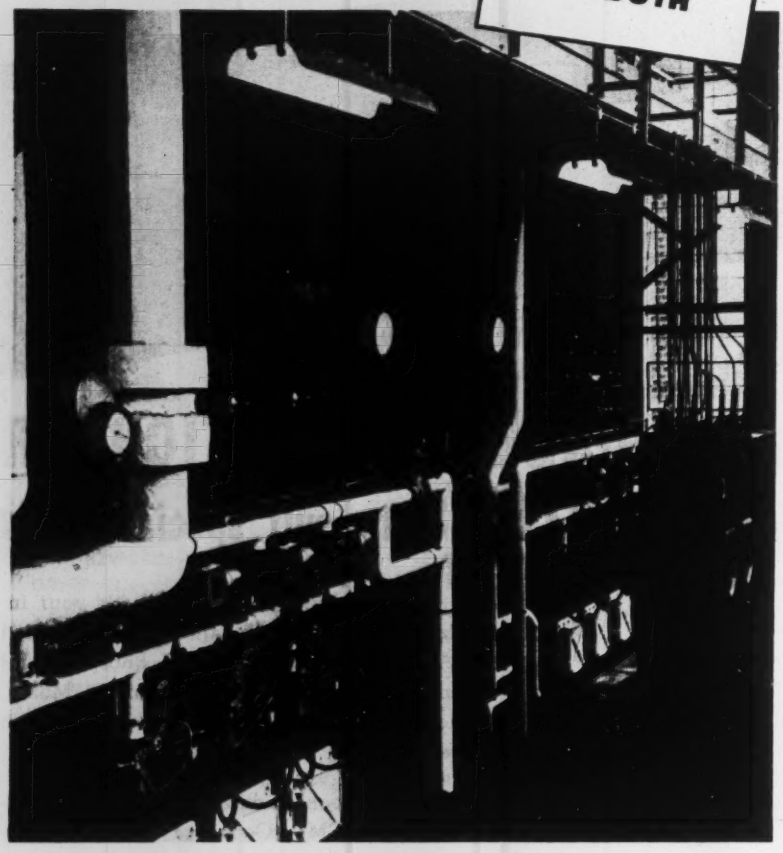
DOWNINGTOWN is experienced in building equipment with Bi-metallic, Finned Tube and Karbate Graphite.

Write on your letterhead for DOWNINGTOWN literature on shell and tube heat exchangers.

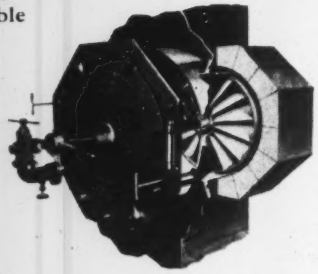
DOWNINGTOWN IRON WORKS, INC.
DOWNINGTOWN-PENNA.
DIVISION OF PRESSED STEEL TANK COMPANY
Hackney
STEEL AND ALLOY PLATE FABRICATION AND HEAT EXCHANGERS

ENCO BURNERS

FOR OIL, GAS OR BOTH



This New England textile mill uses Enco Type K oil burners. When gas is available a gas-burner gun can be added for dual fuel firing.
Combustion in any case is uniform even if steam demands fluctuate suddenly—another economy feature.
This is only one example of economy with Enco Burners—made in sizes and types for every power plant need, including those with very wide load swings. Ask for literature or a special recommendation for your specific, individual oil or gas burner needs. We will give it the benefit of 35 years' experience in solving unique burner problems.



Enco type K oil burning unit

EC-489

THE ENGINEER COMPANY
75 WEST STREET, NEW YORK 6, N. Y.
IN CANADA: ROCK UTILITIES LTD., 80 SEAN TALON ST. W., MONTREAL, P. Q.

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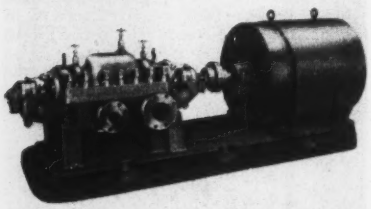
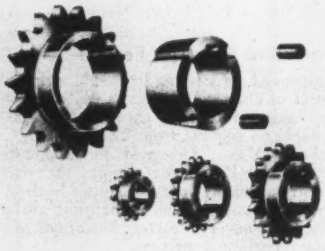
Boiler Feed Pump

Illustrated is one of two 2½-in. six-stage Pennsylvania OHB centrifugal boiler feed pumps installed at Otsego Falls Paper Mills, Inc., manufactured by the Pennsylvania Pump & Compressor Co. These pumps feature a double-suction impeller at the first stage; chrome cast-steel casings and impellers; stainless-steel impeller wearing-rings, casing wearing-rings, and shaft sleeves; carbon steel shafts; split stuffing-box glands; water-cooled stuffing boxes; and heavy-duty, water-cooled, double-row ball bearings.



Service conditions for which the pumps are constructed are: 236 gpm of water at 230 F, 1975 ft TDH, 15.6 ft NPSH, and a full-load speed of 3600 rpm for motor and 3550 rpm for turbine.

Roller Chain Sprockets



Morse Chain Co., a Borg-Warner Industry announces a new line of Taper-Lock Stock Roller Chain Sprockets, as an addition to their present line of stock plain-bore sprockets. The Taper-Lock principle has gained wide acceptance in countless applications with Morse Silent Chain Sprockets, the company declares. Taper-Lock sprockets are keyed to shafts for easy, quick installation and removal, according to Morse engineers, yet grip shafts with the firmness of a shrink fit. They have no flanges or protruding parts and require no more space than standard sprockets. Flush hub design contributes to safe operation. Morse Taper-Lock Sprockets fit any roller chain manufactured to American Standards, No. 40 through No. 100. Morse distributors will stock a complete range of Type B (hub one side) Taper-Lock Sprockets for immediate delivery in ½-in., ⅝-in., ¾-in., 1-in., and 1-¼-in. pitch. Number of teeth range as high as 112. All bushings and the smaller sprockets are individually packaged. Additional information can be secured by writing Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

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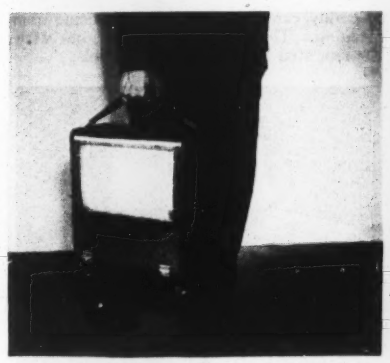
Portable Six-Channel Oscillograph

A new portable six-channel oscillograph, designed for use where the need for a lightweight, compact, and portable instrument is of prime importance, has been announced by the Brush Electronics Co. The model BL-226 Oscillograph is equipped with six Model BL-902A Penmotors which permit the simultaneous recording of six channels of instantaneous electric phenomena, or mechanical phenomena that can be converted to electrical phenomena, in the frequency range of dc to 100 cycles per sec.



A window in the top of the instrument permits viewing the chart as information is being recorded. Controls provide starting, stopping and selection of chart speeds of 5, 25, and 125 mm per sec. A 25-ft length of cable and junction box provides all the necessary outlets for connecting six Brush Amplifiers to the Oscillograph.

As an accessory, a remote control box is provided, permitting the operator to start and stop the chart drive from remote locations. Outlets are provided in both the oscillograph and control box to permit use of a floor switch. A detailed description of the oscillograph may be obtained from Brush Electronics Co., Equipment Div., 34H, 3405 Perkins Ave., Cleveland 14, Ohio.

Stacking Pit

In another step to speed up manufacture of large steam turbine-generators, the General Electric Co., Schenectady, N. Y., has completed construction of a new "stacking pit" at a cost of more than $500,000.

The pit, about 55 ft sq and 24 ft deep, will be used for the core assembly of armatures in the 20-acre turbine plant.

The new pit provides adequate space and heavier equipment for the stacking operation. During this step in manufacturing, the generator frame is placed on end. The armature core is formed by stacking flat steel punchings in approximately a doughnut shape inside the shell. Upwards of 150,000 punchings are used in the armatures of large machines, which are as much as 30 ft long and 12 ft in diam.

As the many layers of punchings are placed in position, giant hydraulic jacks capable of exerting 600 tons pressure are used to press the punchings together.

The average size of G-E turbine-generator sets made last year were about 70,000 kw. This year the average size will be over 77,000 kw.

Previous practice was to use a portion of the factory floor for stacking. With the dimensions of generators increasing, generator frames towering 30 ft or more above the shop floor interfered with movement of cranes needed in other manufacturing operations.

The new pit solves this problem and makes crane operations more efficient. As many as six generator armatures can be "stacked" in the pit at one time.

Inserting Tool for Thread Inserts

The lifetime guarantee has entered the industrial field with Heli-Coil Corp.'s announcement of a new inserting tool molded of Du Pont nylon, for installation of Heli-Coil stainless steel wire thread inserts. The lifetime guarantee states that if the user ever breaks the nylon sleeve in service, he need only return the tool to the manufacturer and it will be replaced at no charge.

Wide World Photo

this could happen in your town

THIS CITY STREET CAVED IN when a water main broke. It's a dramatic, but not an unusual example of what water does to road bedding.

Protect your roads and pipes from the problems of leakage by Centrilining. This patented process thoroughly cleans and centrifugally lines pipes with cement mortar. Leakage, tuberculation and interior corrosion are permanently checked . . . carrying capacity and distribution pressure are increased to "better than new" highs. And the whole process is done with pipes in place . . . no excavation . . . no traffic disruption.

With Centrilining you can save your water mains . . . and streets too.

Write today for free booklet

CEMENT-MORTAR LININGS FOR PIPES IN PLACE

3,000,000 FEET OF EXPERIENCE

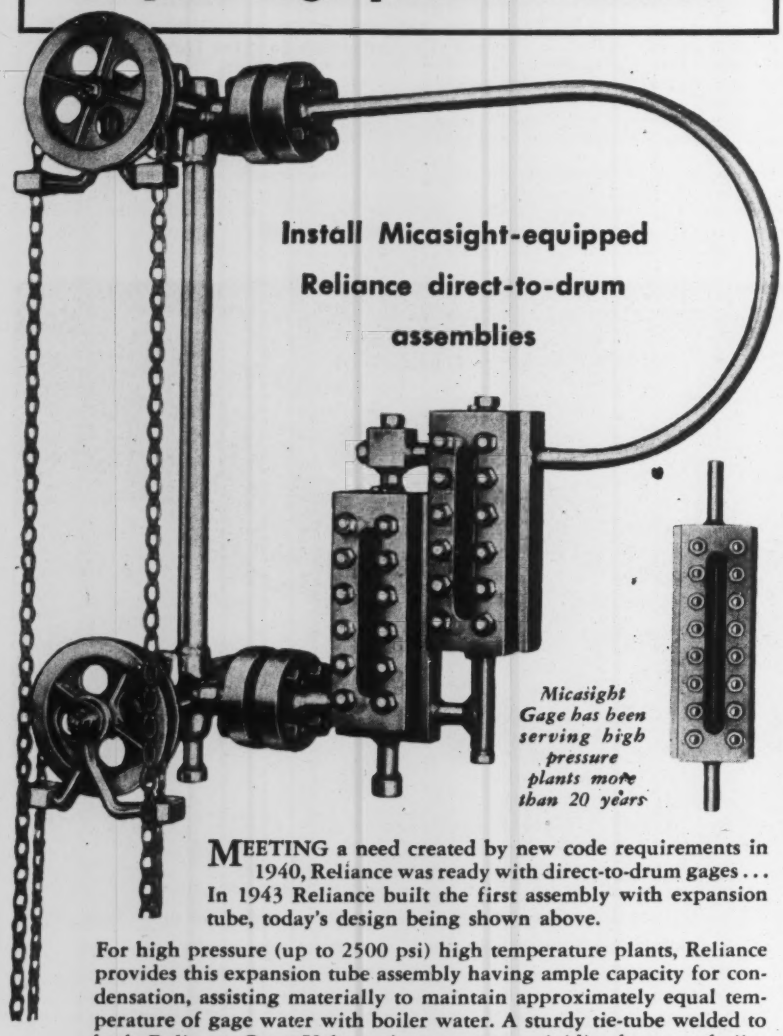
CENTRILINE CORPORATION

A subsidiary of Raymond Concrete Pile Co.

140 CEDAR STREET, NEW YORK 6, N. Y.

Branch Offices in Principal Cities of United States and Latin America

Stop gage glass breakage on your high pressure boilers



Install Micasight-equipped Reliance direct-to-drum assemblies

Micasight Gage has been serving high pressure plants more than 20 years

MEETING a need created by new code requirements in 1940, Reliance was ready with direct-to-drum gages . . . In 1943 Reliance built the first assembly with expansion tube, today's design being shown above.

For high pressure (up to 2500 psi) high temperature plants, Reliance provides this expansion tube assembly having ample capacity for condensation, assisting materially to maintain approximately equal temperature of gage water with boiler water. A sturdy tie-tube welded to both Reliance Gage Valves gives necessary rigidity between boiler connections. Reliance all-welded gage assemblies have more than sufficient ruggedness to meet severest conditions.

Extra gage-reading safety and long window life is assured by the exclusive Micasight Gage which uses non-shattering mica windows securely clamped in short, wide-bar, non-breathing bodies. Reliance provides access to clean out all passages, with entrances guarded by non-freezing plugs. Gage is connected to valves by ring-joint flanges — no nipples or packing glands. The Micasight is the safest water gage known. *Write for full information, to the factory or your nearest Reliance representative.*

RELIANCE GAUGE COLUMN CO., 5902 Carnegie Ave., Cleveland 3, Ohio

Reliance®

BOILER SAFETY DEVICES

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Space Heaters

The Heating Dept, Machinery Div., Dravo Corp., Pittsburgh, Pa., announces the extension of its line of space heaters with the addition of suspended gas-fired units. Suitable for natural, manufactured, mixed, liquid petroleum, sewage, or coke-oven gas, and available with input capacities ranging from 85,000 to 215,000 Btu per hr, the Model D unit heater comes with a standard fan, and Model DB with squirrel-cage blower for short duct runs. Model DD (without blower) is designed as a heating unit to be built directly into air-conditioning duct systems. The cast-iron bunsen-type burner assembly can be removed for servicing and cleaning. The drawer frame slides out with the mounted burners and all controls.

The new gas fired models will enable Dravo more fully to serve commercial and industrial customers who need supplemental heating in decentralized buildings and small office areas. Being in the low-capacity range, the new types now give Dravo a line of gas-fired heaters ranging from 68,000 to 2,000,000 Btu per hr output, with oil- or gas-fired units from 400,000 to 2,000,000 Btu per hr output. All heaters carry American Gas Association approval and are listed by the Underwriters Laboratories. They are all flame-tested before shipment.

Sanitary Control Valve

Saniflo, a new 2-way valve engineered specifically for the sanitary control of food processing operations, has been announced by The Foxboro Co., Foxboro, Mass. Featuring the high flow capacity of an expanded "streamlined flow" body and the friction-free power of the Stabilflo diaphragm motor, the Saniflo valve has the added advantage of quick and easy disassembly for cleaning, a vital factor on such processing equipment as juice heaters, pasteurizers, milk lines, deaerators, and fillers.

All parts exposed to product are Type 18-8, corrosion-resistant stainless steel. The one-piece stem and plunger eliminates threads and crevices which would harbor bacteria formations. To clean, the operator simply snaps the quick-disconnect clamp, removing the Saniflo body, and loosens a hand nut

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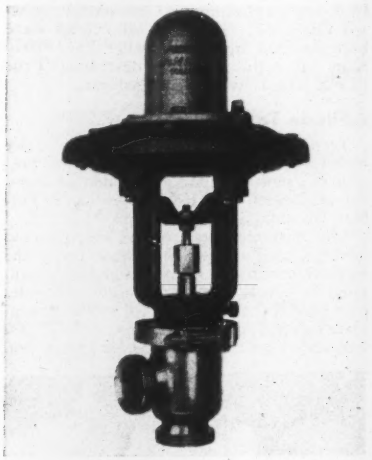
to remove the plunger-stem. There are no gaskets or stuffing boxes to complicate cleaning; Neoprene O-ring seals are used between body and bonnet, bonnet and valve stem.

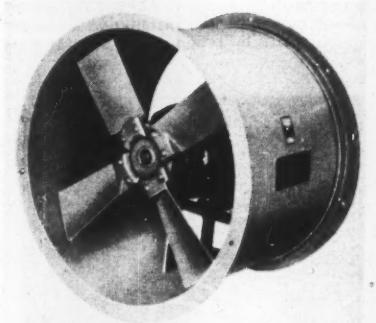


High capacity of the Saniflo valve allows greater flow of product, even in viscous service such as processed cheese, chocolate, liquor, and cream style corn. The plunger is a modified parabolic design, equally effective in throttling (proportional) and open-and-shut control. Single-seat and self-aligning construction provide tight shutoff in closed position.

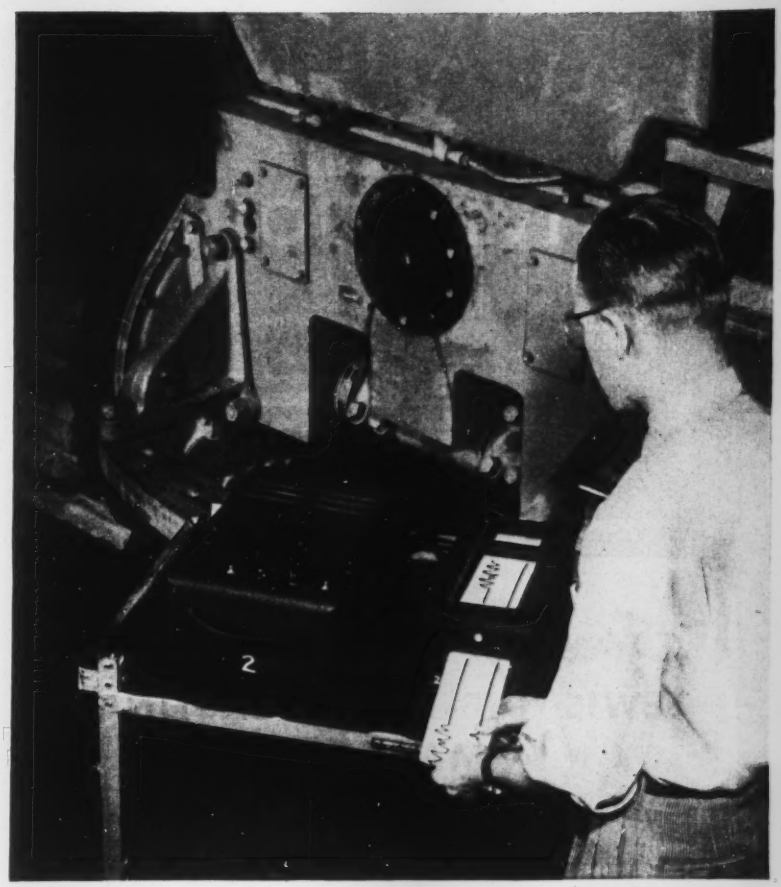
Other features include a reversible diaphragm motor (air-to-open and air-to-close); linear flow characteristics for proportional control; and friction-free motor action (no guides or bearings).

Valve connections are 3A (IAMD thread), male, ground seat type. Standard line sizes, 1 through 3 in., are available.

Duct Fan



The Chelsea Fan & Blower Co., Inc., 639 South Ave., Plainfield, N. J., has announced a new Power-Line Direct-Drive Duct Fan, Type PLFX, designed for factory, mill, mine, and duct installation. The fan is built into a steel drum with rear- and front-mounted flanges. Motors are ball bearing and totally enclosed. The blades are non-overloading and are made of cast aluminum. The manufacturer recommends the fan for temperatures up to 110 F, with availability for higher



DYNAMIC STRAINS
Quickly Recorded

● In this test on operating tractor parts at Caterpillar Tractor Company, strains are "picked up" with resistance-sensitive strain gages. The signal is then amplified and recorded — *instantaneously* — by the Brush Analyzer.

Such immediate strain recording saves engineering time, and eliminates laborious plotting of data. The written records provide a permanent history of tests. This simplified measurement is a boon to product development.

Investigate Brush Recording Analyzers to streamline *your* testing of stress, strain, torque, vibration, pressure, and electrical characteristics. Brush representatives are located throughout the U.S. In Canada: A. C. Wickman, Limited, Toronto. For bulletin write Brush Electronics Company, Dept. P-5, 3405 Perkins Avenue, Cleveland 14, Ohio.

PIEZOTRONICS ... Brush has prepared this informative 24-page brochure describing the functions and applications of piezo-electric materials. Write for your copy—it may spark a product improvement idea.

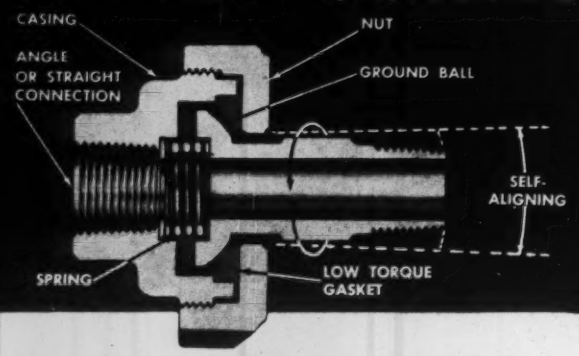
BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

BRUSH ELECTRONICS

formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
Clevite Corporation.

SELF-ALIGNING BARCO SWIVEL JOINTS



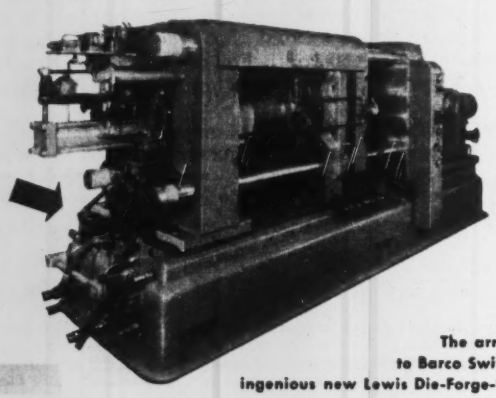
Speed up Adjustments on

LEWIS DIE-FORGE-CASTING MACHINE

LEWIS WELDING & ENGINEERING CORP., Bedford, Ohio, is one of the many well-known machinery builders who rely on BARCO SWIVEL JOINTS for flexible piping connections to *moving* or *movable* hydraulic cylinders. In this case, the cylinder is mounted on the movable strain head of the machine. Thanks to Barco joints, the position of this head can be changed easily at any time without concern about the piping connections. The joints also safely absorb all movement and strain on piping when the machine delivers its final closing force of 650 tons.

Barco Swivel Joints also save time on initial installation of piping because they are *self-aligning*—EXACT PIPE FITTING IS NOT NECESSARY TO PREVENT "BINDING". This is an exclusive Barco advantage. *For complete information, ask for Catalog 265.*

BARCO MANUFACTURING COMPANY
521 F Hough St., Barrington, Illinois (A Chicago Suburb)



The arrow at left points to Barco Swivel Joints on this ingenious new Lewis Die-Forge-Casting Machine.

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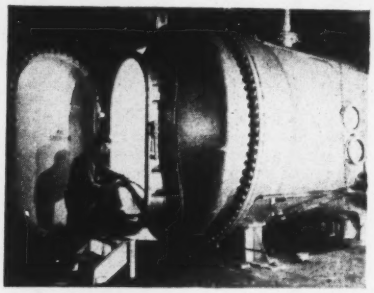
temperatures on special order. Fan sizes are 16 in. to 48 in., capacity 2900 to 37,500 cfm. The fan is also available as Type PLDX, which is belt-driven with the motor and belt out of the air stream. Chelsea states that all its fans are built according to U. S. Dept. of Commerce Commercial Standard CS 178-51, and that all ratings have been certified by the Propeller Fan Mfrs.' Assn. Bulletin No. 503, describing Type PLFX fans, is available on request.

Altitude Test Chamber

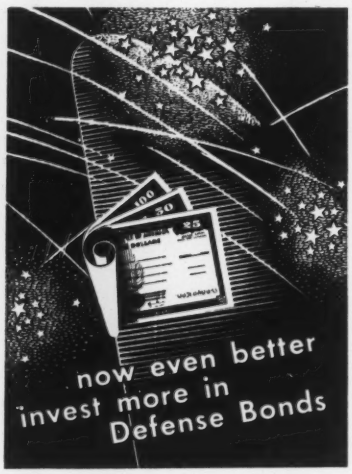
Testing equipment ten miles up in the sky without ever leaving the ground is now possible in a new turbopump altitude test chamber at General Electric's Aircraft Gas Turbine Division facilities at Lynn, Mass.

This chamber is one of the many testing facilities used to test equipment under the severest conditions which could be encountered in actual flight. Simulated altitudes over 60,000 ft can be obtained as well as simulated aircraft climb rates in excess of 20,000 fpm and climb rate angles as high as 60 deg.



Used primarily for testing reheat (afterburner) fuel pumps for jet engines under varied conditions and altitudes, this chamber has a volume of approximately 950 cu ft and can accommodate a 470-gal-capacity fuel tank. Engineers can observe pump operation under all conditions of altitude by watching through observation ports provided in the sides of the chamber.

The entire end of the chamber can be removed to permit the installation of larger equipment to be tested under altitude conditions.



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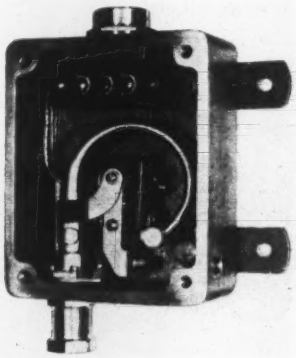
Pressure Switch

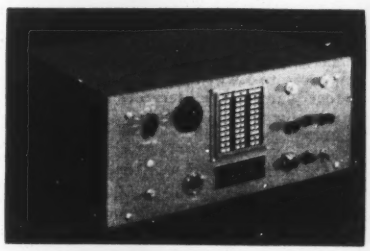
The Meletron Model 314 pressure switch comes in six classes of proof pressures (to 500, 1500, 3000, 4500, 6000, and 12,000 psi). They provide accurate sensing of system pressures over an adjustable range of 15 psi to 10,000 psi and are suitable for liquid, gas, or water systems.



The switch will actuate at any predetermined pressure over the adjustable range, the maker states, and is available with external adjustment if setting requires frequent changes. The variable actuation value ranges from 10 to 2,000 psi, depending on the switch class. Actuation may be on increasing or decreasing pressure, automatically reset by snap action of switch. Skeleton switches, Model 304, with the same operating characteristics but without case, are also available. For further information, write Barksdale Valves, 1566 E. Slauson Ave., Los Angeles 11, Cal.

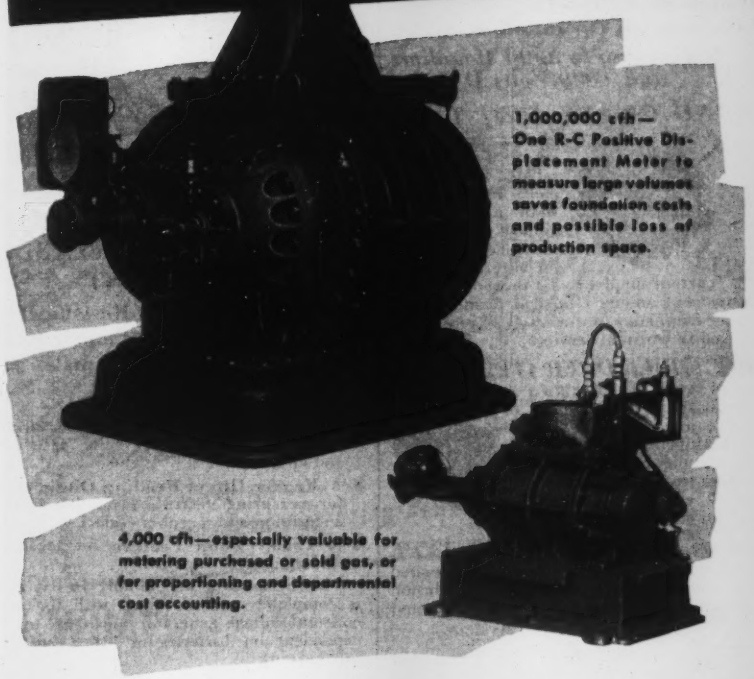
Analog-Voltage Digitizer

The Teleducer, Type 24A, automatically converts analog voltages into decimal digits with an accuracy of 0.1 per cent (1000 counts full scale), according to the manufacturer, Telecomputing Corp., Burbank, Cal.



The Teleducer operates upon demand, digitizes an input voltage, and holds the digital representation for a controllable period of time for purposes of display, recording, or any desired readout form. The digital output can be recorded by means of punched cards, an electric typewriter, magnetic tape, or punched tape. The instrument digitizes low voltage without d-c amplification and high voltage by means of attenuators. It uses a simple-bridge balancing circuit which does not hunt or oscillate and requires only 0.8 sec or less to reach balance.

CALL ON THE "Specialists" FOR ACCURATE METERING


1,000,000 cfh—One R-C Positive Displacement Meter to measure large volumes saves foundation costs and possible loss of production space.
4,000 cfh—especially valuable for metering purchased or sold gas, or for proportioning and departmental cost accounting.

The successful performance of Roots-Connersville Positive Displacement Meters has long been proved by large and small industrial plants and public utilities. These users rate them high in such basic essentials as:

Accuracy—not affected by pressure, wide ranges in loads or other variables. Absence of valves, vanes and other small parts insures "cash register" accuracy over years of use.

Capacity—from 4,000 cfh to 1,000,000 cfh in one unit, with ample ability to absorb overloads.

Compactness—smallest made for industrial use in foot-for-foot of capacity. Can be located in otherwise unusable space, thus saving production areas.

Almost a century of experience in handling gas and air, exclusively, goes into the design and construction of R-C Meters. They're part of the comprehensive line of blowers, exhausters, gas and vacuum pumps and related equipment, which are the products of R-C Specialists, and which are in widest use in industry.

A new bulletin, M-152, gives complete data on R-C Meters, including a handy selection table which simplifies your choice of the right meter to suit your specific application. Your copy will be sent on request.

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BIDDLE *Instrument News*

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Ratings up to 2000 Megohms and 1000 Volts D-C

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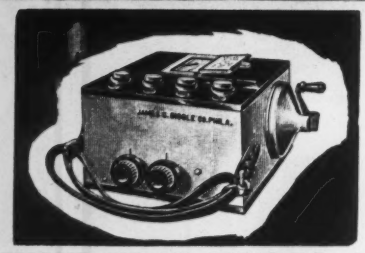
DUAL-OPERATED MEG TYPE of Megger Insulation Tester may be operated by hand or rectifier. Excellent solution for those requiring a versatile instrument for field and bench use.

Write for BULLETINS 21-45 ME 21-46 ME



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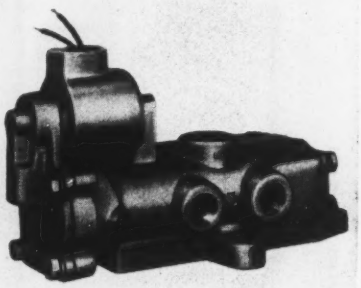
KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Four-Way Poppet-Type Solenoid Valve

The Automatic Switch Co., Orange, N. J., has placed on the market a new Super-Duty 4-Way Packless Poppet-Type Solenoid Valve. The new valve is claimed to operate up to 750 cycles per min intermittent duty and up to 500 cycles per min continuous duty with air or gas as the medium. The valve will also operate on oil or water.



The valves are recommended for high-speed operation on machine-tool and press-service applications. Further uses are suggested by the fact that the 4-way operation can be changed by the user into a 5-way operation by replacing the rear plate.

Design features include: poppet-type, beveled stainless-steel seats and disks; guided, inserted seats with no threads; few moving parts; short stroke; and mill-type construction.

The main valve is power operated in both directions. Pressure return of the pilot core eliminates sticking due to residual magnetism or possible binding. The valve can be mounted in any position without affecting proper operation. Valve connections may be made to the front, rear, and top, or may be brought into the bottom for pad-type mounting. The standard solenoid enclosure meets both watertight and explosion-proof requirements. The unit has no stuffing boxes of any type.

Body construction is of bronze with stainless steel valve seats and disks. Standard I.P.S. threaded connections are used. Four sizes are available: $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1 in. pipe connection, each capable of being converted from 4-way to 5-way by the user by changing the rear plate. Free literature is offered by the manufacturer. This valve is listed as Bulletin 8344.

Heavy-Duty Metal Turnings Crusher

The new American 60-50 Metal Turnings Crusher, according to the manufacturer, is the largest metal turnings crusher ever built, Designed to reduce metal turnings, aluminum castings, such as crankcases, pistons, pots and pans, etc., and many other forms of scrap at a rate of 35 to 50 tons per hr, this crusher is recommended for large-scale operations in industrial plants, aluminum smelters, and metal recovery yards.

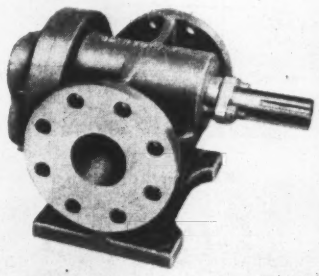
The basic construction of the American 60-50 is similar to the other models of American metal turnings crushers, but is larger and more massive throughout, with a capacity three to four times greater than their standard models. For further information and literature, write to American Pulverizer Co., 1541 Macklind Ave., St. Louis, Mo.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Rotary Gear Pump

A new rotary gear pump of simplified design has been announced by the Sier-Bath Gear & Pump Co., Inc., 9252 Hudson Blvd., North Bergen, N. J. According to the manufacturer, this simplicity makes possible high quality at low cost. Primarily for positive displacement of lubricating liquids, the "Hydrex" Pump will handle fluids and semi-fluids, 32 ssu to 250,000 ssu. Capacities are 1-500 gpm; 300 psi for continuous duty, 500 psi for intermittent service.



The simplicity of the "Hydrex" is indicated by the use of two castings for the body and the head and two moving parts, the two rotors. Features of the "Hydrex" are: rotors are precision-made gears; pumps are hydraulically balanced axially; shaft is hardened and ground at stuffing box; heavy-duty roller bearings are used; all connections over 2 in. are flanged; and all machined surfaces are ground for easier piping and aligning.

Mechanical-Trouble Detector

A new tool designed specifically for locating and diagnosing mechanical troubles through the medium of sound has been developed by the Jas. P. Marsh Corp., Skokie, Ill. The instrument is claimed by the manufacturer to be excellent in detecting and locating imperfections in all types of mechanical equipment. The sounds of leaking valves, defective bellows, wrist-pin and bearing knocks, piston slaps, grinding gears, valve noises, turbulence, and a great many other mechanical difficulties can be detected and identified.

The Marsh Serviceman Soundscope consists of an ear-piece containing a sound-box system and transmitter, with a diaphragm capable of picking up sounds which cannot be heard by the human ear and amplifying them until they are clearly audible.

HOW HEAT
(UP TO 2200° F)
CAN BE STOPPED COLD

Destructive effects of extremely high temperature can be minimized—by using Kentanium at the critical points.

WHAT is Kentanium?

Chiefly titanium carbide (and small percentages of other refractory metal carbides), with nickel "binder". Uses neither tungsten nor cobalt. Hardness: Up to 93 RA. Weight: ⅔ that of steel.

WHAT can it do?

Resist thermal shock, withstand oxidation and abrasion, retain great strength at high temperatures (1800°F and above).

WHERE is it in use?

Successful applications include: Valves, valve seats, reduction crucibles, anvils for spot welding, hot extrusion die inserts, bushings, thermocouple protection tubes, flame tubes, furnace tong tips, balls for hot hardness testing, nozzle vanes and blades for jet engines, and many others.

WHAT forms are made?

Tubes, rods, bars, flats by extrusion process. More complex parts by machining from pressed slugs before sintering, extremely accurate parts by grinding to required tolerance after furnace sintering.

HOW can you use it?

This remarkable new metal, available in many "grades" to meet specific combinations of imposed conditions, can best be adapted to your high temperature problem by cooperative effort. Our engineers will be glad to discuss how you can get best results from Kentanium.

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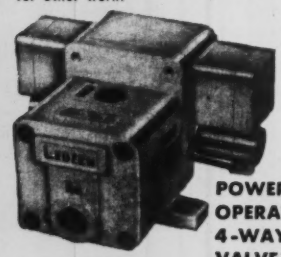
Three models: Completely Manual—Spring Return to Neutral—Spring Return to Reverse. Flow cycles to handle most requirements.

FOOT OPERATED 4-WAY VALVE

Same as Hand Operated Valve, except foot operation replaces hand. Leaves hands free for other work.



POWER OPERATED 4-WAY VALVE

For remote control, safety or automatic equipment. Suitable for solenoid, cam, finger, toe or hand operation.

Ledeen valves are built in sizes from ⅛" to 1¼" standard pipe tap—to operate air and hydraulic cylinders and motors, single and double acting.

Write for Bulletin 1000

VALVES • CYLINDERS
AIR-HYDRAULIC PUMPS & BOOSTERS
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Los Angeles 15, Calif.

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Sandblasting Barrels

Pangborn Corp., of Hagerstown, Md., has introduced airless Blastmaster Rotoblast Barrels with 3- and 18-cu-ft capacity barrels, as well as 6- and 12-cu-ft capacity sizes. The two new Blastmaster Barrel sizes (3GN and 18GN) will include all of the construction features of the presently available sizes.

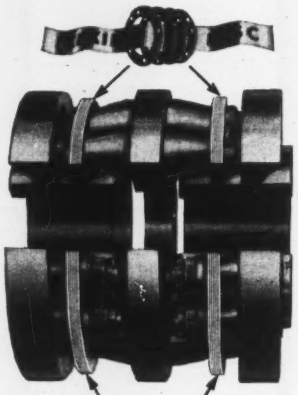
During barrel operation, the cleaning and reclaiming system removes all sand and debris and maintains the full efficiency of the abrasive. The 3GN barrel (3 cu ft) is powered by two $^1/_2$ hp and one $1^1/_2$ hp motors. The 18GN (18 cu ft) uses two $1^1/_2$ hp and one 15 hp motors.

Thermistors

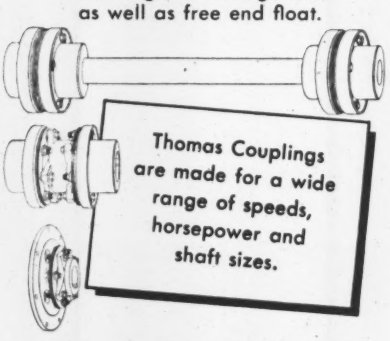
A new high-resistance Veco thermistor has just been announced by the Victory Engineering Corp., of Union, N. J., manufacturers of thermistors. This type 71A2 thermistor is sealed in a glass rod and has a temperature coefficient of −7 per cent per deg C at 0 C. Its resistance at 0 C is 60 megohms and drops to 3 megohms at 50 C. Developed to fill a special requirement of Westinghouse Electric Corp. and now in quantity production, this Veco thermistor lends itself to several other applications, among them making the period of electronic R-C timing circuits independent of changes in ambient temperature.

Specify THOMAS ALL METAL FLEXIBLE COUPLINGS for Power Transmission to avoid Costly Shut-Downs

DISTINCTIVE ADVANTAGES	
FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.



Thomas Couplings are made for a wide range of speeds, horsepower and shaft sizes.

THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

NO MAINTENANCE PROBLEMS

ALL PARTS ARE SOLIDLY BOLTED TOGETHER

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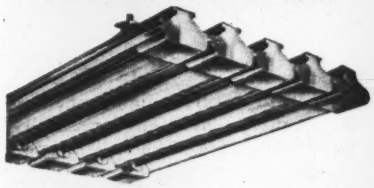
THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

GET ALL 3 with ALL-METAL CHROMALOX RADIANT HEATERS



Uniform heat at the turn of a dial is yours with CHROMALOX Electric Radiant Heaters. Fingertip control assures exact operating temperatures for varying needs. Different zones of heat can be had within the same oven by setting up individual controls for each bank of heaters. CHROMALOX Units operate in low and high ambient temperatures; provide glareless radiation in infrared wave lengths absorbed efficiently by all colors, textures, surfaces. All-metal construction withstands shock, vibration, moisture; eliminates contamination; is safe with volatiles.

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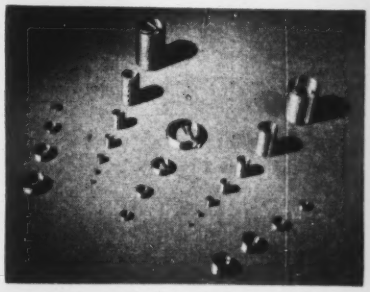
Wire Thread Inserts

Heli-Coil Corp., Danbury, Conn., has announced the availability of 47 standard sizes of wire thread inserts: five in the automotive spark plug series, 17 in the National and Unified coarse thread series, six in the National pipe thread series, 15 in the National and Unified fine thread series and four in the aviation spark plug series.

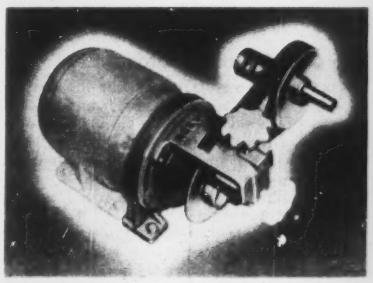


A break-down of these size ranges is as follows: 10-1.0 mm to $^7/_8$-18 in the automotive spark plug series; 4-40 to $1^1/_2$-6 in the National and Unified coarse thread series; $^1/_8$-27 to 1-$11^1/_2$ in the National pipe thread series; 6-40 to $1^1/_2$-12 in the National and Unified fine thread series; and 14-1.25 mm to 18-1.5 mm in the aviation spark plug series. Inserts for the National and Unified thread series are supplied, in 1-, $1^1/_2$-, 2-, $2^1/_2$-, and 3-diameter lengths. For special applications, non-standard thread sizes and lengths can also be supplied.

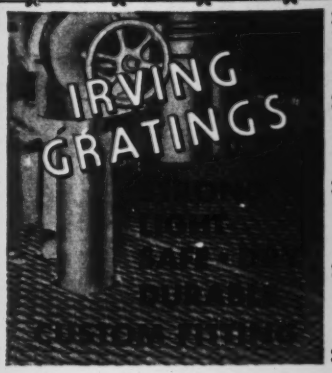
Heli-Coil wire thread inserts are used in the following manufacturing industries: automotive, aviation, home appliance, shoe machinery, construction equipment, air conditioning, business machine, motorcycle and sports car, marine engine, textile equipment, coin machine, furniture, material handling, electronic equipment, railroad, and heavy industrial machinery.

Variable-Speed Drive

Reeves Pulley Co., Columbus, Ind., has introduced the Flexi-Speed Drive, a new variable speed unit for which it claims unmatched flexibility in operation and application with low unit cost.



Flexi-Speed Drives may be mounted in almost any position around the driven equipment, may drive in any direction, and can deliver any desired speed within a ratio of 8 to 1. The speed control handwheel may be located parallel to or in any of eight positions perpendicular to the motor shaft. Six different length belts offer a choice of shaft center



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IN THE NAVY, IN EDUCATION, SCIENCE, ENGINEERING, AND IN WAR—BY W. F. DURAND

Past President of The American Society of Mechanical Engineers.

Here Dr. Durand records what he considers to be the most interesting and important events of his life. They include his researches at Cornell on the performance of ship propellers, the aeronautical engineering problems which engaged his attention at the NACA where he served as its first chairman and in other capacities for nearly thirty years, and his activities after his retirement from Stanford University as consultant on the Hoover Dam and other similar projects and as a leading participant in the encyclopedic summary of Aerodynamic Theory.

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These autobiographies are warmly recommended for their vivid portrayal of two pioneers at work and for the interesting picture they reveal of expanding technology in two important fields.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 West 39th St., New York 18, N.Y.

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distances. Flexi-Speed Drives are presently available in capacities of 1/2, 3/4, and 1 hp. They are adaptable to industrial applications with in-line or right-angle reducers, countershafts, chain and sprocket, or V-belt drives. For complete details, write for Bulletin V-532.

Automatic Liquid-Level Control Valve

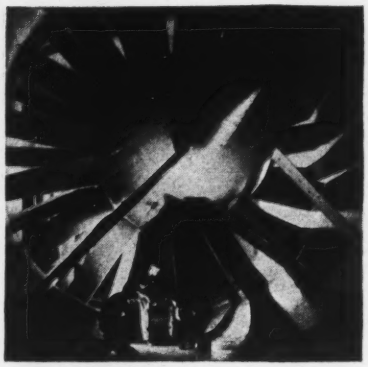
A new pressure-reduction valve, known as the Automatic Liquid-Level Control, has been developed by the Helco Products Corp., 2041 Colorado Ave., Santa Monica, Cal. This valve has been designed primarily to maintain a very low and sensitive outlet pressure. The valve can be adapted to many uses in diverse types of equipment where a steady water or other liquid level is to be maintained automatically. Helco engineers say it takes the place of float valves, wherever a closed system is desirable because of sanitary requirements or corrosive conditions. The control operates in a range of inlet pressure from 5 psi to 260 psi and can be set to maintain a steady water level in a range from 5 in. to 20 in. The Helco engineering staff cooperates in adapting its valve to meet specific needs, and will furnish samples upon written request.

Boiler-Feed-Pump Motor

A new boiler-feed-pump motor for use in power-generating stations has been announced by the General Electric Co.'s Medium Induction Motor Dept. Available in ratings of 1000 hp and larger, the new motor features an improved ventilation system, cubical design, a special high-speed rotor, and quieter operation.

The ventilation system of the motor discharges the heated air away from workers and other nearby motors. The air is drawn in from the motor's sides and expelled at a higher level from the shaft end of the motor over the couplings and boiler feed pump.

To blend with modern power station styling, the over-all width of the G-E motor has been reduced by cubical design. Savings in floor space can thus be realized, according to company engineers, because the motors may be mounted closer together.



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At Boeing, facilities like the newly redesigned wind tunnel—the only privately owned trans-sonic tunnel in the country—help engineers get ahead. Here, also to help you, are acoustical, hydraulic, pneumatic, mechanical, electronics, vibration, and physical research laboratories. You may work on such long-term projects as America's first-announced jet transport, supersonic flight and nuclear-powered aircraft research, on guided missiles, or B-47 and B-52 jet bombers.

Boeing offers careers of almost limitless range to men in virtually ALL branches of engineering (mechanical, civil, electrical, aeronautical, and related fields), for aircraft **DESIGN, DEVELOPMENT, PRODUCTION, RESEARCH and TOOLING**; to servo-mechanism and electronics designers and analysts, and physicists and mathematicians with advanced degrees.

Boeing pays you a moving and travel allowance. You can work in either Seattle or Wichita. Both of these cities provide fine fishing, hunting, golf, boating and other recreational facilities—as well as opportunities for specialized advanced training. You'll be proud to say, "I'm a *Boeing* engineer!"

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Engineering opportunities at Boeing interest me. Please send me further information.

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NEW EQUIPMENT
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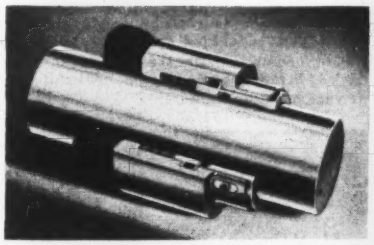
O-Ring Mechanical Seals

Simplicity of design is an important feature of Garlock's new O-ring mechanical seals for rotating pump shafts. The small number of parts, the maker says, affords easy manufacturing adaptability of the seal to withstand any liquid, whether mild, harmfully corrosive, or extremely hazardous, on rotating pump shafts.

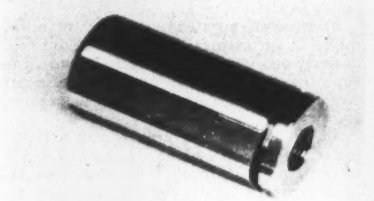


These O-ring seals are designed to provide leakless operation of rotary shafts on centrifugal pumps handling chemicals, petroleum products, edible liquids, pulp liquors, and many other liquids. They are furnished in Type O, an unbalanced seal for pressures up to 200 psi, and in Type OB (illustrated), a balanced seal for pressures up to and over 1000 psi. Both types can be supplied with single spring or multiple spring, and in either pin-drive or sleeve-drive construction.

Type O seals are furnished for packing spaces $^{5}/_{16}$ in. and larger. In some cases, Type O seals can be made for $^{1}/_{4}$ in. packing space. Type OB seals are furnished for packing spaces $^{3}/_{8}$ in. and larger. The O-rings are available in Teflon, Buna-N, Neoprene, or Silicone. The metal parts contacting the liquid can be furnished in any suitable metal. For additional information, write The Garlock Packing, Co., Palmyra, N. Y.

Check Valve

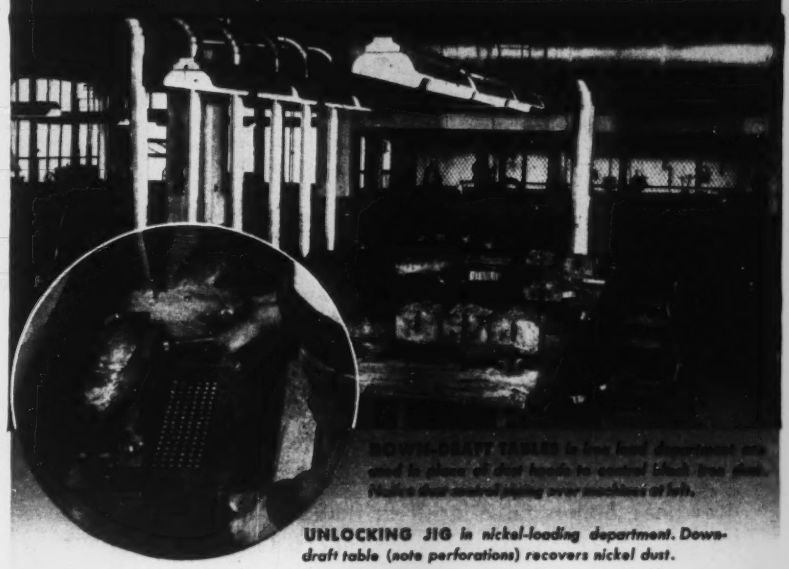
Instead of using an O-ring for its seal, the new Anco Check Valve has a valve seat formed of two hardened steel pieces which are designed, ground, and lapped for long life. Another advantage cited by the makers Anco, Inc., of Providence, R. I., is that the device, which consists of seven parts in all, has only one moving part.



No pressure is lost through the valve, it is reported, and cracking pressure is 5 lb or below at all pressures. The Anco Check Valve is produced regularly in aircraft and standard pipe sizes, and can be made to withstand chemical reaction of the materials being handled. These valves are produced in forged aluminum for aircraft and in steel

Pangborn Dust Control *pays for itself* in recovered material

at Thomas A. Edison, Incorporated



UNLOCKING JIG *in nickel-loading department. Down-draft table (note perforations) recovers nickel dust.*

MANUFACTURING nickel-iron-alkaline storage batteries at Thomas A. Edison, Incorporated, creates nickel, nickel-hydrate, and iron-oxide dusts. Control and recovery of these valuable dusts was complicated by their light weight, which in some processes prevented the use of regular dust-collecting hoods. Pangborn engineers solved this problem by utilizing down-draft tables in a unique dust control system geared to Edison's particular requirements.

RESULTS? The Pangborn system pays for itself in recovered dust alone. In addition, the dust-free atmosphere has improved working conditions in the plant. Although this Pangborn dust control system is a major installation, it was completed without loss of a single day's production!

WHAT ARE YOUR DUST PROBLEMS? Find out how Pangborn can help you. Mail the coupon below today for Bulletin 909-A.

Look to Pangborn for the latest developments in Dust Control and Blast Cleaning equipment

Pangborn DUST CONTROL

STOPS THE DUST HOG from stealing profits

PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Md.

Gentlemen: Please send me a copy of Bulletin 909-A.

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MORE EXPERIENCE
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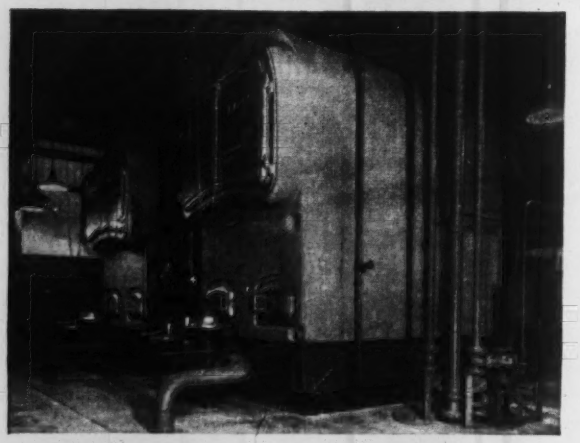

KEWANEE
STEEL BOILERS

Kewanee Boilers have led their field for more than 85 years because Architects, Engineers, Contractors and owners know they *get more from them* . . . and that is true because *Kewanee puts more into them.*

Check the measurements and specifications shown in every Kewanee catalog. You'll find more of all the features which make a boiler efficient and dependable . . . large, high fireboxes; generous heating surfaces; unimpeded water ways; unobstructed steam release areas; plenty of space for reserve steam. That's why one finds Kewanee Boilers "on the job" providing heat or power or process steam in America's finest buildings and industrial plants.

KEWANEE-ROSS CORPORATION
Division of American Radiator & Standard Sanitary Corporation
KEWANEE, ILLINOIS

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for commercial application. In all sizes, internal passage areas through the Anco valve are in excess of the pipe size being used. Complete information on the Anco Check Valve is available from Anco, Inc., of One Baker St., Dept 39A, Providence, R. I.

Two-Millionth Engine

Wisconsin Air-Cooled Engine No. 2,000,000 made by Wisconsin Motor Corp., whose products are delivering an estimated 26 million horsepower throughout the country, came off the assembly line Nov. 12, 1952, and was immediately earmarked for the enviable duty of being a "Show Engine" for exhibition at various trade shows.

Seventeen years were required to produce the first million Wisconsin air-cooled engines, but only five were needed for the second. Company officials say present indications are that the third million will be produced within four years. A plant expansion is now under way to provide an additional 41,000 sq ft for a new experimental laboratory and additional storage space, which will provide a total floor space of 291,000 sq ft for Wisconsin Motor Corp.

Although originally set up for the manufacture of water-cooled engines in a power range up to 200 hp, including engines for old-time automobiles such as Stutz, Kissell, Cutting, Case, and FWD trucks, as well as special jobs for racing cars, the company switched to an exclusive air-cooled engine policy in 1941.

At present, approximately 500 manufacturers of agricultural, construction, oil field, railway maintenance, industrial, and other types of equipment specify Wisconsin air-cooled engines as standard or optional power equipment.

Shown in the photograph are (left to right): Peter Zagorski, president of Local 283, UAW-CIO; A. F. Milbrath, vice president and chief engineer; A. J. Brown, plant superintendent; E. C. Wurtz, vice president in charge of manufacturing; Phil Norton, vice president and general sales manager; and H. A. Todd, president.

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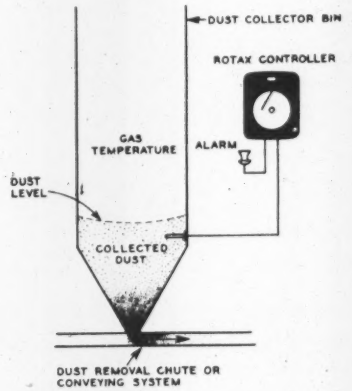
Dust Level Control System

Fly ash, collected in a Cottrell precipitator in the power plant of a Midwestern public utility, is automatically measured and the bin level controlled by a single instrument, a Model 40 Rotax Controller, product of The Foxboro Co., Foxboro, Mass. Details of the low-cost system and its applications in chemical, power, and processing plants are contained in the new Engineering Data Sheet, 823-12, available on request.

A temperature bulb, mounted inside the precipitator, normally senses the higher temperatures of the flue gases from which the dust is precipitated. When the dust deposit covers the bulb (acting as insulation) the controller, responding to the resulting lower temperature, completes an electrical circuit through its Rotax contacts to sound an alarm and alert the operator.



If desired, the Rotax Controller can be installed to operate a screw conveyer, belt, or other motor-driven equipment, automatically emptying the bin or tank when the desired level is reached.

The system is equally effective for most bulk materials, provided their temperature in the bin is considerably above or below the ambient temperature.

Automobile Body Corrosion

Factors that influence the corrosion of automobile bodies and some possible remedial measures were discussed by F. L. LaQue, a leading authority on corrosion, in a talk before the National Passenger Car, Body and Materials Meeting of the Society of Automotive Engineers, held in Detroit, Mich., March 3. Mr. LaQue is head of the Corrosion Engineering Section of International Nickel's Development and Research Division in New York and a past president of the National Association of Corrosion Engineers.

Mr. LaQue said that the severity of the corrosive action encountered by automobile bodies is determined by the nature and amount of corrosive pollutents in the air in which the cars operate, plus the superimposed effects of materials thrown up from the streets or roads. Attack is also influenced considerably by the humidity of the atmosphere and the amount of rainfall, as well as the presence of particles of dust, ashes and soot which have a major effect in promoting corrosive attack.

The principal corrosive constituents of atmospheres are the products of combustion of various fuels in industrial areas and salt

SAVE STEAM, SPACE AND WEIGHT... INSTALL

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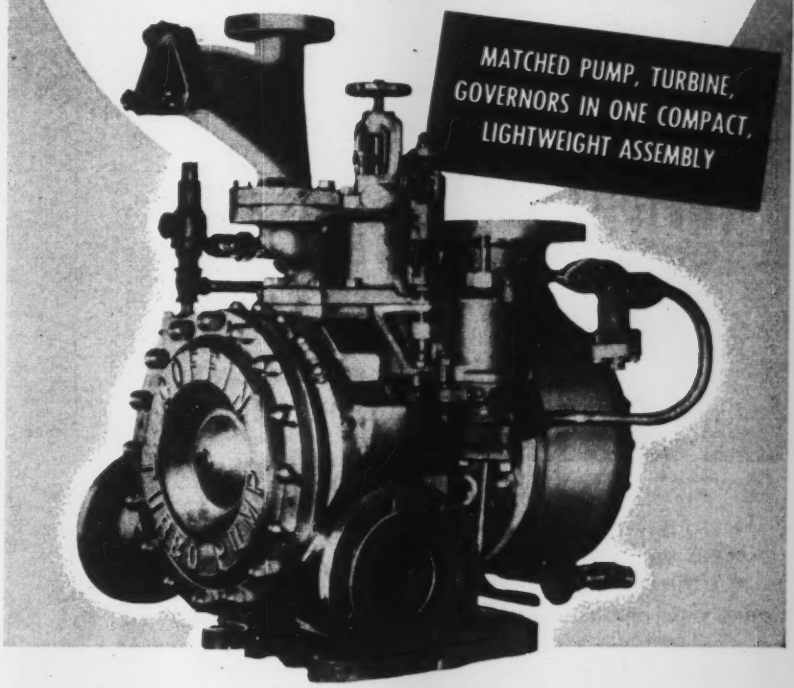
Designed and built expressly for boiler feed service, Coffin high pressure, single stage turbo pumps conserve steam on even the most difficult pumping assignments. All parts are standard and replacements are easily installed without fitting. New Handbook available now – for free copy, address Dept. ME.

– for high efficiency boiler feed service!



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particles blown in from the ocean in coastal regions. To these may be added nitric acid generated by synthesis from nitrogen and oxygen by the action of atmospheric discharges, lightning. Mr. LaQue said that, contrary to popular belief, heavy rainfall and high humidity do not necessarily cause accelerated corrosion of steel. As a matter of fact, frequent and heavy rainfalls wash off corrosive chemicals and corrosion-stimulating dust particles.

The steels used for automobile bodies are not selected with resistance to corrosion as a major consideration, Mr. LaQue said. Emphasis on low cost and fabrication qualities, he said, tends to favor compositions of steel that may approach a minimum rather than maximum resistance to atmospheric corrosion. Resistance to corrosion can be raised by the addition of appropriate amounts of such alloying elements as phosphorus, chromium, and nickel. Added protection can also be achieved by giving the steels a phosphate pretreatment before painting.

Prefabricated Tunnel Piping Systems

Supplementing its line of prefabricated insulated piping, The Ric-wiL Co. has recently developed a large-diameter conduit system for protection of underground distribution piping and other utility services. It is designed to meet the service-tunnel requirements of industrial plants, colleges, hospitals, municipalities, etc.

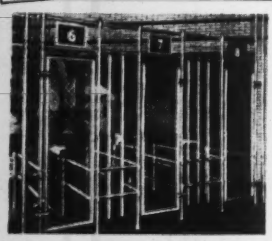
Known as the Ric-wiL Utilidor, the system is completely prefabricated to job requirements with distribution piping for steam, condensate, water lines, fire lines, or process purposes all in place and insulated where required, including traps, valves, and expansion devices. Provision may also be made for electrical and communication cables, ceiling lights, etc. Utilidors are shipped in units approximately 21 ft long with simple joint connections and fittings, such as tees and elbows, prefabricated to fit into the conduit runs.

The heavy-gauge housing is constructed of corrugated ingot iron conduit, hot-dip galvanized and protected with asphaltic phenolic resin coatings. Conduit diameters range from 36 in. to 84 in., depending on the nature and number of services to be housed. Walk-through space may be provided in large-diameter Utilidors, which makes possible periodic inspection, maintenance, or alteration of the interior services, as well as allowing room for pedestrian passageway or conveyor systems between buildings if desirable.

Structural uses for ALCOA ALUMINUM PIPE

Easily assembled with Nu-Rail* Slip-on Fittings of Alcoa Aluminum.

GUARD RAILINGS



PIPE ENCLOSURES

PROTECTIVE RAILINGS

*Manufactured by Hollaender Manufacturing Company, 3841 Spring Grove Avenue, Cincinnati 23, Ohio

- No threads to cut!
- No welding!
- Time savings on all jobs!

OTHER TYPES OF FITTINGS ALSO AVAILABLE

Advantages of Alcoa Aluminum Pipe:

1. LOW MAINTENANCE COST—Withstands most contaminated atmospheres without paint.
2. GOOD APPEARANCE—Bright, clean-looking.
3. STRONG—Has excellent mechanical properties.
4. LIGHT—Weighs 1/3 as much as steel, size for size.

With all these advantages, first cost is moderate. Schedule 10 costs little if any more per foot than Schedule 40 steel.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

Most ALCOA distributors and jobbers stock Schedule 10 and 40 pipe and fittings in standard sizes. ALCOA can supply other sizes to your specifications. Consult your local ALCOA Sales Office or write: ALUMINUM COMPANY OF AMERICA 903-E Alcoa Building Pittsburgh 19, Pa.

For Production-Boosting IDEAS

Show these MOVIES without cost or obligation!

New Hit

"Blanking and Forming with Multipress" . . . This 16mm sound film brings 10 minutes of fast action showing the *how* and *why* of methods applied to several production jobs . . . highlights important press features—*and shows one of the fastest hydraulic press operations you've ever seen.* Ideal for your next ASME or student group meeting, training school session, or production clinic.

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"MULTIPRESS—and how YOU can use it" . . . 30 minutes of Multipress at work on actual, unstaged operations such as broaching, trimming, forming, marking, crimping, assembling, staking and testing.

"INDEX TO PROFITS" . . . A 20-minute film showing the 13-stage assembly of an intricate 34-piece automobile door latch through a production line that cuts waste space and lost motion to the bone.

WRITE DENISON or contact the Denison representative in your area giving your film choice and preferred showing date.

The DENISON Engineering Co.
1189-A Dublin Road Columbus 16, Ohio

DENISON HydrOILics

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For additional details, typical layouts, and suggested specifications, The Ric-wiL Co. Union Commerce Bldg., Cleveland 14, Ohio, will send Utilidor Folder Form 5210 to those who request it on company letterhead.

Pocket Pyrometer

An optical pyrometer in pocket size is available to American industry, it has been announced by Allied Engineering Division of the Ferro Corp., Cleveland, Ohio.

The diminutive telescope-like pyrometer, a German product, will be distributed in the United States solely by Allied Engineering. It weighs only $5^1/_3$ oz. and is used for direct reading of temperatures up to 3300 F produced by heat radiating from a hollow space.

The pocket pyrometer is suitable for the ceramic, chemical, and metallurgical fields, either in laboratory or spot-checking work. It uses a small bimetal spiral spring as radiation tracer, whose free end is provided with a pointer being subject to the influence of temperature. The measuring spiral is artificially aged by temperature changes before being installed in the pyrometer. The bimetal indicator-thermometer is arranged in a telescope-like housing of approximately $2^1/_3$ in. outside diameter and $6^1/_2$ in. total length in the focus of a convergent lens. There is a built-in eyepiece on the opposite side. Through this, the observer can view the object as well as the deflection of the needle on a calibrated scale.

The fixed end of the measuring spiral is corrected by a second bimetal spiral not influenced by radiation. This will avoid any adulteration of the indication by other temperatures than those of the calibration. Any deviation from the initial value of the scale can be corrected by turning this second spiral through hand adjustment of the eyepiece. The pyrometer is protected against strong sun rays as well as radiation from electric torches by a handy case. For eye protection, a red glass disk to be mounted on the eyepiece is furnished by the manufacturer.

Before starting to measure the temperature, a bright object of normal atmospheric temperature, such as a bright window, is sighted. If the indicator does not show zero, this deflection is corrected to zero by turning the eyepiece.

Readings can be taken at once, and are indicated distinctly on a scale calibrated in degrees Fahrenheit. The direction of view on the radiating aperture, a furnace peephole for instance, should lie approximately in the axial direction of the peephole.

and now...
a standard system
of SUPPORT for
INSTRUMENT
TUBING

Cope
INSTROF

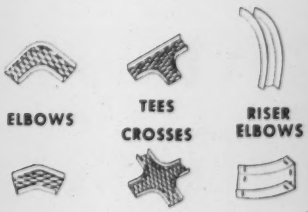
★ strong
★ light ★ safe
★ economical

COPE INSTROF is a system of pre-fabricated steel parts that can be quickly and easily assembled and erected in new or old constructions for the continuous support of instrument tubing. It is extremely versatile in application and is adaptable to all needs as standard fittings allow for changes in direction or elevation.

Connectors are secured with nuts and bolts so assembly time is held to a minimum. Hot dip galvanizing of all parts assures long life.

COPE experienced engineers will gladly help you plan the installation. Write now for Bulletin 65-1 for further details.

T.J. Cope INC.
711 SOUTH 50th ST.
PHILADELPHIA 43, PA.

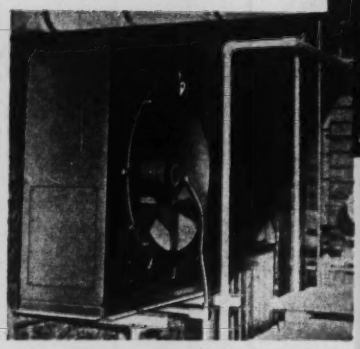


and other necessary fittings

Announcing

The WING Package— DRAFT INDUCER

FOR POWER PLANTS

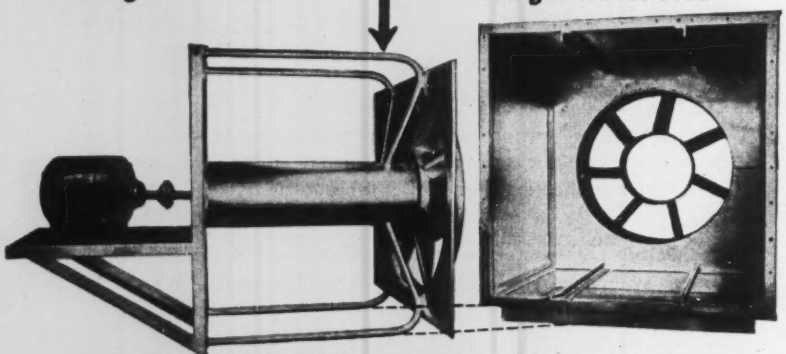


Motor (or Turbine) and Fan in one complete removable unit

In this new high-pressure "Package" Draft Inducer, the motor (or turbine) and fan unit, completely independent of the casing, makes installation considerably easier, and being easily removed, facilitates inspection and maintenance.

ADVANTAGES

1. **Big saving in space requirements**
2. **Compactness permits fewer and lighter structural supports**
3. **Eliminates field line-up problems**
4. **Eliminates water cooling**
5. **Only two supporting bearings**
6. **Wide flexibility in gas inlets**
7. **All moving parts quickly and easily accessible**
8. **Saves on investment and maintenance**
9. **Low load ratings on natural draft because of Wingfoil Fan and ample free gas travel area**



Wing Package Draft Inducers are available in many sizes with either turbine or electric motor drive. For further information write

Wing

L. J. Wing Mfg. Co.

156 Vreeland Mills Road,
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FACTORIES: Linden, N.J. and Montreal, Can.

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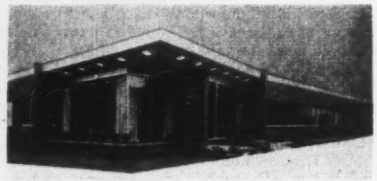
Warehouse Air Conditioning

The new food warehouse for Wrigley's Stores, Inc., in Detroit, shown in the photograph, is one of the largest structures of its kind in the country. The one-story building encloses a total volume of 7,000,000 sq ft, with storage space for 1,000,000 cases of can-packed groceries, and refrigerated rooms and coolers for meats, dairy products, and other perishables. The building also includes Wrigley's business offices.



Marlo equipment was selected to meet the air conditioning requirements in this warehouse. Marlo Floor and Ceiling units and a Marlo Evaporative Condenser help to provide the refrigerating protection necessary to maintain the quality of Wrigley's food products. The units are manufactured by Marlo Coil Co., 6135 Manchester Ave., St. Louis 10, Mo.

Architect for Wrigley's new warehouse was Louis G. Redstone. C. L. Toonder & Associates were engineers. General contractor was Campbell Construction Co., and mechanical contractor, Mally Corp.

US Franchise for ASEA Induction Furnace

The Pittsburgh Lectomelt Furnace Corp. has been exclusively licensed in the United States to produce electric induction furnaces developed by Allmanna Svenska Electriska Aktiebolaget (ASEA) of Vasteras, Sweden, according to announcement by William Wallis, Lectromelt's president.

The licensing makes Lectromelt the second manufacturer of this type of melting furnaces in America.

As successfully developed by Sweden's ASEA since 1926, its high-frequency induction furnace is essentially a thin-walled crucible surrounded by a specially designed coil of water-cooled copper tubing. After the crucible has been charged with melting stock—a large furnace unit will melt a 12-ton heat at five tons an hour—an alternating current of controlled frequency and intensity is sent through the coil. An induced magnetic field then penetrates into the charge and rapidly heats and melts it.

Power for the furnace is supplied by a high-frequency generator which varies in size depending upon the holding capacity and melting rate of the furnace. Lectromelt is cataloging the induction furnaces in 11 sizes with nominal charge capacities from 500 lb to 15 tons.

Among advantages claimed for high frequency induction furnaces are their special adaptability to the melting of alloy steels, stainless steel, tool steels, and similar products. Many such furnaces are used, however, for smelting in the gray iron field. The induction furnace also is very flexible in operation and is particularly adaptable to the manufacture of small alloy-steel castings. Alloy losses are reported as exceedingly low in this type of operation.

A vital message to the head of the family

Two ways you can protect your family against CANCER

. . . a check
. . . a check-up

Cancer strikes in one of every two families. Each year more than 60,000 American children under the age of eighteen lose a parent to cancer.

Yet many cancers can be cured, if discovered in time.

Every man should have a complete physical examination once a year. Women over thirty-five should have a complete physical examination twice a year.

Because of scientific advances, patients are being cured today who could not have been saved even five years ago.

The American Cancer Society asks your help in the fight against cancer. Your check today will help pay for costly research. Will help keep physicians informed of latest developments in detection and treatment. Will help pay for the training of doctors to specialize in cancer.

How soon we find cancer's cause and cure depends on how soon and how much help comes from people like you.

Invest your money today for your family's security tomorrow.

"Cancer" c/o Postmaster, (Your town)

Please send me free literature about cancer.
Enclosed is my contribution of
$_____ to the cancer crusade.

Name_____

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Cancer strikes One in Five
STRIKE BACK . . .
Give to Conquer Cancer

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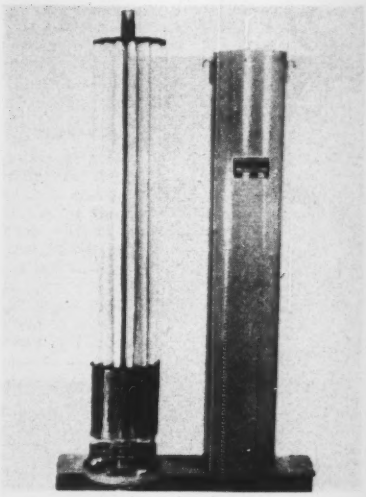
Compressed-Air Filter

Hankison Corp., of Pittsburgh, Pa., announces the development and production of the new Model A-100-D Condensifilter, a unit to filter and dehydrate compressed air.

The new Model A-100-D Condensifilter uses a new type of disposable filter cartridge which is constructed of wire mesh and flannel cloth and provides over 24 sq ft of filtering area, an increase of 37 per cent over previous models. When the filter becomes dirty, the entire cartridge is replaced by removing one nut at the top of the Condensifilter.



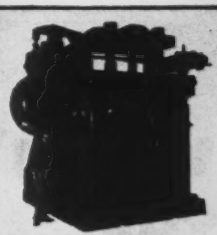
The condensing unit is engineered to provide the maximum heat exchange area. More than 950 sq in. of surface area cools the compressed air traveling through the condensing section. The dewpoint of the air is lowered to within two or three degrees of the temperature of the cooling water used, and water and oil, in both entrained and vaporized states, are removed by condensation.

The Model A-100-D Condensifilter also incorporates a snap-action, spring-loaded trap. Accumulated condensate is discharged through the trap valve, which is designed to prevent leakage or pressure loss. A descriptive bulletin covering construction features, technical data, and dimensions is available by writing to Hankison Corp., 216 Biltmore Bldg., 951 Banksville Rd., Pittsburgh, Pa.

Loading Ramp

A new hydraulically operated loading ramp for transfer of materials from loading docks to trucks and trailers will be the feature display of Rotary Lift Co., Memphis, Tenn., at the Materials Handling Exposition in Philadelphia, May 18–22.

Called the Leva-Dock, this new loading ramp supplies automatic adjustment to truck and trailer beds of varying heights, compensating 4 ways for out-of-level variances and spring deflections during loading or unloading. A built-in safety device locks the new Leva-Dock automatically in position in case of sudden movement of the vehicle.



"NO SHUT-DOWNS WITH LUBRIPLATE"

—say HENRY & WRIGHT
of Hartford, Conn.

"While waiting for delivery of one of our 25-ton Dieing Machines to do a particularly heavy job, a customer was trying to start production of a 10-ton machine. Even though it was lubricated with a conventional grease every eight minutes, the machine had to be shut down for bearings to cool during each coil run. Then, on our recommendation, he changed to a LUBRIPLATE Lubricant. With but two applications of LUBRIPLATE a day, the machine operated continuously except during change of coils."

For nearest LUBRIPLATE distributor, see Classified Telephone Directory. Send for free 56-page "LUBRIPLATE DATA BOOK". . . a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

The Standardaire
Axial Flow Positive Displacement Blower

for increased air handling efficiency . . .

Consider a Standardaire Axial Flow Positive Displacement Blower *first*. Its unusual design features provide the greatest output per pound of weight ever achieved in this type of blower.

The Standardaire Blower employs an exclusive means of compression which provides a wide range of pressures with a minimum of internal losses. It can be operated at high speeds, permitting direct drive by favorably priced, standard motors in an efficient speed range.

Air is drawn in and discharged smoothly. Compression is gradual and free from the shocks which load internal parts and decrease efficiency.

These are but a few of the unique features of this compact unit which assure outstanding results. For further information, write . . .

CORPORATION

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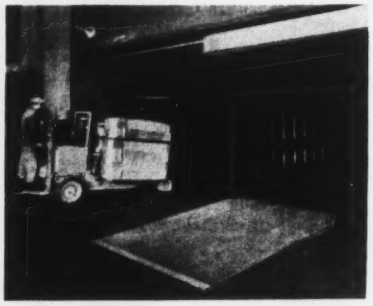
Torque-frame construction carries the motor and equipment on the torque-bar for easy access for maintenance purposes. No separate oil reservoir installation is required, according to the maker, and costly piping and wiring are eliminated, as well as the delays for maintenance work. The control-switch for each Leva-Dock is a separate unit and can be located in any place convenient for operation.



Four steel sections comprise the Leva-Dock platform. The unit is locked into position when not in use to become an integral part of the whole loading platform and takes a load up to 20,000 lb rolled in any direction.

Complete details on the new Leva-Dock loading ramp will be available at the Rotary Lift Display, Booth No. 338, at the Materials Handling Exposition in Philadelphia, or from Rotary Lift Co., P. O. Box 2177-A, Memphis 2, Tenn.

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that his products . . . the service in them and the service behind them . . . will stand up under the most searching scrutiny of the high calibre engineers and executives comprising MECHANICAL ENGINEERING readership.

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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

BUSINESS NOTES

New B & W Plant

The Babcock & Wilcox Co. has announced purchase of a tract of land south of the city of Wilmington, N. C., will start immediately to erect a $2,000,000 plant to build boilers and related equipment, according to C. H. Gay, vice president of the company.

The property purchased is 153 acres in what is known as the Maffitt Village development. This will be the second plant of the company to be located in Wilmington, and the fifth new plant to be added to the company's Boiler Div. in a little over a year, making a total of seven plants in the division. In making the announcement, Mr. Gay pointed out that the new plant would mean that the company had more than doubled its productive capacity in the Boiler Div.

The new plant will employ about 750 men when it gets into operation about the middle of June, Mr. Gay said. The total area under roof will be about 135,000 sq. ft. In addition, there will be 1500 ft of uncovered craneway. The plant will do such operations in the fabrication of large industrial boilers as bending tubes, building drums and headers, and assembling reheater sections.

Golden-Anderson Expands

Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., has acquired the shop and equipment of Imperial Machine Works, Inc. The increased production facilities of this new addition, which contains over 20,000 sq ft of usable floor space, were needed to take care of the heavy demand for Golden-Anderson products.

Ohio Injector Acquires New Product Line

Acquisition of the extensive lubricated plug valve business of the H. K. Porter Co., Inc., in Tulsa, Okla., has been announced by the Ohio Injector Co., of Wadsworth, Ohio. The semi-steel and steel valve production equipment of the Porter Co., formerly the Hinderliter Tool Co., will be moved to the Wadsworth, Ohio, plant of Ohio Injector.

Clark Railways Dealer

In line with its current program of "expanding and improving" sales and service operations and facilities, the Clark Equipment Co. of Buchanan, Battle Creek, and Jackson, Mich., announced appointment of the Mississippi Supply Co., Chicago, Ill. as an authorized dealer in the railway field.

The new Clark dealer's activities will be confined to a group of railroads with headquarters in Chicago.

Gray Appoints Representative

The G. A. Gray Co. of Cincinnati, Ohio, has announced the appointment of Harrington Wilson Brown Co. of New York, N. Y as representatives for the sale of their complete line of planers, planer-type milling machines, and horizontal boring, drilling, and milling machines, in eastern New York state, southern Connecticut, northern New Jersey, and the northeastern counties of Pennsylvania.

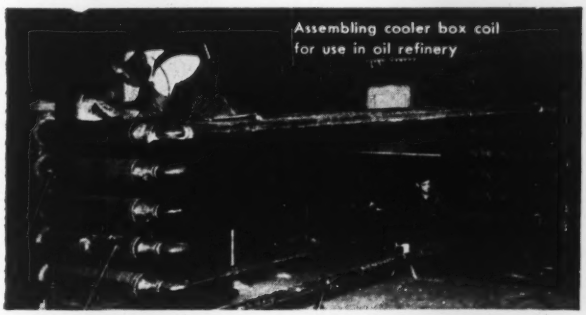
Foxboro New Kansas Branch

The Foxboro, Co., Foxboro, Mass., has opened a new branch office at Wichita to serve instrument users in the Kansas area. Located at 2207 South Pinecrest, the new branch brings the Foxboro total to 42 offices within the United States, reflecting the growing demand for instrument engineering in all phases of industrial processing.

Rust-Oleum Distributors

The Rust-Oleum Corp., 2799 Oakton Street, Evanston, Ill., manufacturers of rust-preventives for over 25 years, announces the addition of two new industrial distributors to its nation-wide distributor sales organization.

The newly appointed distributor firms are: Clark-Fontana Paint Co., 1455 "P" St., S. W., Washington D. C.; and Empire Supply Co., Jamestown, N. Dak., Bismark, N. Dak. and Fergus Falls, Minn.


Assembling cooler box coil for use in oil refinery

SPECIALISTS for SPECIAL PIPING JOBS

No special piping design presents too great a challenge for Western Piping Supply's many specialists. Engineers, pipe benders, welders, or the men who align, heat treat, or test—all have the skill and good judgment bred of long experience. These men stand ready to handle all your pre-fabricated piping requirements, whether of special or conventional design.

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THE LUMMUS COMPANY
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Representatives in Major Cities
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Now your EARS can "SEE" those hidden troubles

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. . . cuts servicing and maintenance costs

Most effective instrument ever developed for pin-pointing and identifying mechanical defects. Saves time and dollars tracking down troubles in bearings, gears, mechanisms . . . detects leaks, knocks, piston slaps—any defects that make a sound. A precision instrument of Marsh quality, sensitive to faintest sounds . . . with handy probe and headband as illustrated. A remarkable tool, moderately priced.

Ask for Circular

MARSH INSTRUMENT CO.
Sales affiliate of Jas. P. Marsh Corporation
Dept. 29, Skokie, Illinois

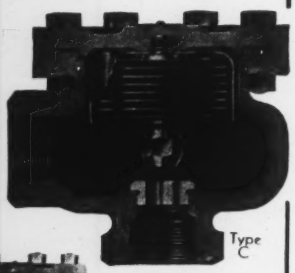
LEADING PROCESSOR

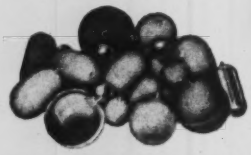
SHORTENS OPERATION

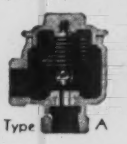
from 65 to 45 Min.

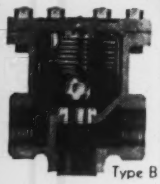
with Nicholson Steam Traps

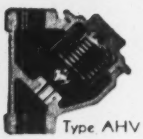
Records of a recent installation of Nicholson steam traps, by a large processor, show they cut cooking time 30%; e.g., one operation was shortened from 65 to 45 min. Nicholson units keep equipment full of live steam because: 1) they operate on lowest temperature differential; 2) have 2 to 6 times average drainage capacity. Also record low for steam waste; and maximum air-venting capacity. Widely specified for preventing damage to thin gauges; eliminate cold blow in unit heaters.











5 TYPES FOR EVERY PURPOSE—SIZE ¼" to 2", pressures to 250 lbs. BULLETIN 152.

HIGH-PRESSURE FLOATS — Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. BULLETIN 650

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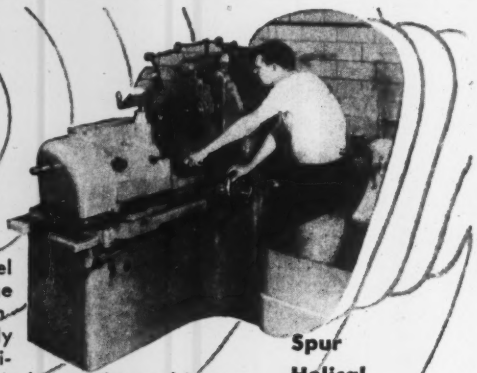
W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

ears for gears



Because minimum noise level is so important in some applications, we will—whenever required—individually sound check gears for maximum silence in operation. Modern testing and inspection equipment—such as that illustrated—is available to electronically check gears for exacting noise limits, under a specified load and RPM. Through such thorough inspection quiet operation is assured.

The next time you have a special gear need, let quiet gears help reduce unnecessary noise—specify The Cincinnati Gear Company. Write, wire or call for full information.

Spur
Helical
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*Coniflex Bevel
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Spline Shaft

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KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

G. E. Jet Plant Known as Evendale Plant

The General Electric Company's J-47 jet-engine manufacturing plant near Cincinnati, Ohio, will be officially known now as the "Evendale Plant."

After operating for more than four years as the "Lockland Plant," this jet-engine manufacturing center was renamed to agree with a redesignated geographical location.

Since beginning operation in 1948 with 100 employees in 7000 sq ft of floor space, the Evendale Plant has expanded until it now employs almost 11,000 persons and occupies 4 million sq ft of floor space.

Westinghouse to Build Welding-Electrode Plant

Westinghouse Electric Corp. will build an ultramodern plant for the manufacture of welding electrodes and brazing alloys near Montevallo, 38 miles south of Birmingham, Ala.

This will be the first welding electrode plant in the South and plans call for a one-story steel and brick structure, running more than 400 ft along state Route 25, and the most modern materials-handling system available.

In addition to welding electrodes for normal industrial use, it will be equipped to produce some of the newest and latest types of electrodes that are being developed for Armed Forces' requirements.

Denison Engineering Houston Branch

The Denison Engineering Co. of Columbus, Ohio, manufacturer of oil hydraulic equipment, has opened a branch office at 1200 Bissonnet, Houston 5, Tex., to headquarter the company's Southwestern sales and service operations.

Mr. W. C. Denison, president of the firm, states that rapidly increasing use of the company's popular line of HydrOILic Equipment in oil-field operations has made this expansion necessary. The new branch is staffed by trained engineers and personnel from the Columbus plant. Manager of the branch will be Mr. Denison Neale.

Clark Texas Dealer

The Clark Equipment Co. announced the appointment of the Towne Industrial Equipment Co., Inc., of Dallas, as its authorized dealer in 129 Texas counties. The Towne Industrial Equipment Co., a Texas corporation with headquarters at 1410 S. Akard Street in Dallas, has been engaged in the sale of materials handling equipment since 1948.

The Towne company's territory is bounded on the East by the Arkansas and Louisiana state lines; on the south by and including Navarro, Limestone, Falls, Milam, Williamson, Travis, Hays, Comal, Kendall, Medina, Uvalde, Kinney, Val Verde, and Terrell Counties; on the west by and including (south and west) Terrell, Crockett, Upton, Glasscock, Howard, Borden, Garza, Dickens, Motley, Hall, Donley, and Wheeler counties; and on the north by the Oklahoma state line. T. G. Frazee, the Clark dealer of whose territory this area originally was a part, continues operations in other parts of Texas, and maintains his headquarters in Houston.

KEEP INFORMED

NEW EQUIPMENT
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Kewanee-Ross of Canada

Richard N. Mathews has been elected vice president of Kewanee-Ross of Canada, Ltd., and placed in charge of the firm's new general offices at 57 Bloor Street West in Toronto, W. Bradford Russell, president, has announced.

The recently formed company was established to provide engineering and sales service to Canadian industry on all types of shell and tube heat-exchangers, coolers, surface and barometric condensers, steam-jet ejectors, and high-pressure steam boilers. "Ross type exchangers are well known in Canada," Mr. Mathews said, "having been made for the Canadian market for over twenty years by Horton Steel Works, Ltd., of Fort Erie, Ontario. The actual equipment will continue to be made by Horton, with engineering by Kewanee-Ross."

The new company is a division of American Radiator & Standard Sanitary Corporation and is affiliated with Kewanee-Ross Corporation of Kewanee, Illinois and Buffalo, New York.

G. E. Opens New FHP Plant at Linton, Ind.

The General Electric Co. completed another step in its decentralization program with the opening of a multi-million-dollar plant for the manufacture of fractional-horsepower motors at Linton, Ind. The plant will be engaged in the production of the company's newly developed Form G motor.

The plant will manufacture split-phase motors for fans, blowers, centrifugal pumps, office appliances, and other general applications where moderate starting torque and quiet smooth performance are needed.

The new Form G motor embodies an entirely new concept of motor design and manufacture. According to G-E engineers, the line to be produced at Linton weighs from 20 to 40 per cent less per horsepower than the models it replaced, and is considerably smaller in size. At the same time, versatility of application has been broadened and appearance modernized.

Industrial Chemicals Division Announced by Michigan Tool

Michigan Tool Co. of Detroit announces the formation of a separate division to manufacture and market a line of industrial chemical products which have been under development at Michigan Tool Co. for the past several years. The new division will be known as the Shear-Speed Chemical Products Div. Headquarters and sales offices will be located at 7125 E. McNichols Road, Detroit 12. A factory building in Detroit has been acquired and installation of equipment is under way.

Announcement of the various products to be marketed by the Shear-Speed Chemical Products Div. will be made as rapidly as production facilities are placed in operation. Field tests in actual use, supplementing laboratory type investigations, have been completed on at least one of the new products to be announced shortly.

Larry A. Bard has been named manager of the new Shear-Speed Chemical Products Div. by Marvin R. Anderson, executive vice president of Michigan Tool Co.

ALLIS-CHALMERS

AC ALLIS-CHALMERS

FOUNDROMATIC GENERAL PURPOSE SHAKEOUT

Cope is being hoisted from drag as flask is shaken out.

Isolated by LORD BONDED-RUBBER LATTICE MOUNTINGS

Lord Bonded-Rubber Lattice Mounting supports shakeout equipment, isolates vibration of screen providing protection for motor and drive assembly.

Lord Bonded-Rubber Lattice Mounts are used for support of Foundromatic Shakeouts and Aero-Vibe Screens manufactured by Allis-Chalmers. The lattice design permits the load to be carried by the rubber in shear—the softest practical type of rubber support. Installed under the machine, the lattice mounting eliminates the overhead supporting structure necessary with the overhead coil spring suspension system.

This is another illustration of how Lord Bonded-Rubber parts are being used profitably in many industries. Consult with Lord engineers on your vibration or shock problems. We invite your inquiry.

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DETROIT 2, MICHIGAN 7310 Woodward Ave.
NEW YORK 16, NEW YORK 280 Madison Avenue
CHICAGO 11, ILLINOIS 520 N. Michigan Ave.
CLEVELAND 15, OHIO Room 811 Hanna Bldg.

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER

Headquarters for VIBRATION CONTROL

What do you know about the Moly-sulfide LUBRICANT?

A LITTLE DOES A LOT

You may have heard about a highly successful solid-film lubricant which is giving remarkable results in the shop and in the field.

In one 40-page booklet we have collected 154 detailed case-histories describing how difficult lubrication problems have been overcome by molybdenum sulfide. If you wish to be up to date about this solid-film lubricant, write for a free copy now.

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KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Foxboro Expands at Dallas

New factory facilities for the assembly of control valves were recently acquired at Dallas, Texas, by the Foxboro Co., Foxboro, Mass. Convenient to the office address, 1710 N. Akard St., the new quarters practically double the area devoted to valve assembly and warehousing, and will facilitate rapid delivery and service to industries throughout the South and Southwest.

Also indicative of the trend towards custom-engineered control are the recently expanded valve production facilities at the Foxboro Home Factory, supplemented by Foxboro Branch Factory assembly and service at Pittsburgh and San Francisco. Industries in Canada and abroad are served by the Foxboro Co., Ltd., Ville LaSalle, P. Q., and Foxboro-Yoxall, Ltd. of London, England.

Inter-Plant Helicopter

A new seven-passenger S-55 Sikorsky helicopter, said to be the first ever used for "corporate" travel, is helping Rockwell Mfg. Co. solve transportation problems between its main offices in Pittsburgh and seven plants within an approximate 200-mile radius.

An organization composed of 17 operating divisions extending from Oakland, Calif., to Brooklyn, N. Y., Rockwell decided that a helicopter was the most practical method of transporting executives, staff members, and manufacturing components required on an emergency basis between its facilities in western Pennsylvania and throughout the state of Ohio.

The helicopter's home base in Pittsburgh is located in a specially marked section of the company's parking lot. Heliports have been inexpensively prepared in the parking lots of the seven other plants visited regularly by Rockwell representatives.

Because of the widespread and diverse activities of the company, transportation of officers and staff members is regarded by W. F. Rockwell, president, as a key to effective management coordination and efficient utilization of management manpower. Since most Rockwell Pennsylvania and Ohio plants are located in small, often isolated communities, commercial air and rail travel facilities have in the past resulted in the loss of hundreds of hours of executive time each year.

"The obvious solution to our problem," Mr. Rockwell explained, "was to purchase an airplane. But when we investigated that possibility, we found that our position would not be greatly improved. It's at least a 30-min ride from our Pittsburgh headquarters to the nearest airport, and in some of our plant cities suitable landing facilities are not available, or are at some distance from our plant sites. A helicopter seemed to afford the most practical solution to our specialized problem: that of providing a taxi service between plants."

"In the past," he added, "we sometimes became concerned because our key people were not getting around enough to our outlying plants. Now there's seldom a day that goes by when someone doesn't have business to perform in one of the seven locations covered by the helicopter. In fact, the real indication of the effectiveness of the helicopter is that we are now giving serious thought to a priority system so that we can take care of all the requests for travel."

Methods,

Process Engineers

Interested in a man-sized job?

If you're an experienced engineer who's looking for a man-sized job, investigate the challenging openings now available at Honeywell.

The prime force behind the 20th century industrial revolution is automatic control. Here at Honeywell it's meant that we have been, and will continue to be, faced with an ever greater production job. That's why we have a real need for "engineers of production."

Duties of the jobs. Figure ways to make quality products at minimum cost. Supervise the tooling, processing and planning necessary to transform blueprints into finished products.

Requirements. B. S. or M. S. in Mechanical, Electrical, Industrial or Chemical Engineering.

Atmosphere. A company which is growing rapidly, steadily and soundly.

Openings. In Minneapolis and Philadelphia.

For details write Mr. Ross Wagner, Personnel Dept., ME-5-86, Honeywell, Minneapolis 8, Minnesota. And be sure to ask for our new book, "Emphasis on Research."

MINNEAPOLIS **Honeywell**

H HONEYWELL

First in Controls

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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Western Gear Spokane Office

The formal opening of the Western Gear Works Spokane branch sales and engineering office at 2605 North Division St., Spokane, Wash., has been announced by T. J. Bannan, president of the company. This office brings the products, facilities and engineering services of the gear-making company to eastern Washington, northern Idaho, and Montana. Lewis F. Parsons will serve as manager of the Spokane office.

LATEST CATALOGS

Air-Operated Chucks

Catalog No. PO-64-1952 describes the air-operated chucks, cylinders, and accessory equipment manufactured by the Cushman Chuck Co. List prices are given, and each chuck, cylinder, and piece of equipment is illustrated along with complete dimensional data necessary for installation.

Header Die

A new header die manual that tells how to drill, assemble, and finish series HN rough-cored header die nibs employing the new grade 190 tungsten carbide is announced by Carboloy Dept. of General Electric Co. Besides outlining advantages and applications of grade 190 tungsten carbide, the nine-page publication, D-131, includes information on nib standards, heading die design, shop equipment, and other data for preparing nibs and header die casings. Standardization of the HN series header die nibs has reached the point where they can accommodate over 90 per cent of production requirements, according to Carboloy Dept.

Industrial Metals Chart

An unusual metals chart, showing the compositions of all commonly used metals and alloys in industry, has been prepared by Sam Tour & Co., Inc., a New York City firm of research and testing consultants. The chart lists the constituent elements and the percentage composition ranges for 60 different classes or types of metals arranged in the following groupings: light metals, irons, steels cobalts, nickels, coppers, white metals, precious metals, heavy metals, and special purpose metals. Also shown is the atomic number and specific gravity of each of 48 elements commonly encountered in industrial metals.

Approximate dimensions of the chart are 16 by 34 in. A two-page explanation accompanies the chart, describing the purpose of the chart and giving useful definitions of various types of metals. Copies of the chart may be obtained upon request to Sam Tour & Co., Inc., 44 Trinity Place, New York 6, N. Y.

Herringbone Gear Drives

A new 36-page Book No. 2519 on herringbone gear drives has just been published by Link-Belt Co. It offers detailed information about Link-Belt single-, double-, and triple-reduction enclosed herringbone gear drives.

Herringbone gear drives are widely used to transmit power at required speeds to conveyors, line shafts, blowers, pumps, agitators, hoists, machine tools, processing machines, and other industrial equipment. Installation photographs in Book 2519 show examples of these drives in many types of heavy duty service.

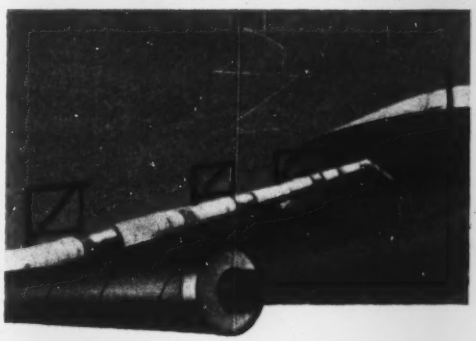
Drive housings are equipped with magnetized oil drain plugs to collect ferrous metal particles from the lubricant. Grease-lubricated seals at all shaft openings prevent entrance of dirt of water into housings. Roller bearings are used throughout.

The horsepower rating tables in Book 2519 contain many new ratios. Ratings for input speeds of 720 to 1750 rpm are given for all drive sizes. Complete instructions for correct selection are provided, including new overhung load tables and a table listing load classes for 170 types of machines.

Book 2519 lists 39 sizes of drives in 534 standard ratios, from 2.84:1 to 326:1. Capacities range from 0.4 to 2480 hp, and output shaft speeds range from 2.2 to 623 rpm. Link-Belt Co., can also furnish herringbone multi-speed drives, high speed drives, increaser drives, and custom-built drives to meet particular specifications. Standardized packaged drives, with motor, baseplate, geared coupling, and single-, double-, or triple-herringbone gear drive, are listed with dimensions and NEMA motor frame numbers. Book 2519 will be sent on request.

Over 85% of the torque wrenches used in industry are
TORQUE WRENCHES
Read by Sight, Sound or Feel.
● Permanently Accurate
● Practically Indestructible
● Faster—Easier to use
● Automatic Release
● All Capacities
in inch ounces . . . inch pounds . . . foot pounds
All Sizes from 0-6000 ft. lbs.
STURTEVANT TORQUE MANUAL
Every manufacturer, design and production man should have this valuable data. Sent upon request.

RIC-WIL KEEPS THIS WATER LINE FROM FREEZING!



PROBLEM: City officials of Ishpeming, Michigan were concerned with providing the most economical method of connecting an elevated water storage tank at the top of a hill into the distribution system, with the line protected from freezing. Due to the ledge rock terrain, both an underground pipe line and rock tunnel were rejected as too costly and impractical.

SOLUTION: Working closely with Ric-wiL's engineering department, the consulting engineers devised an overhead Ric-wiL supply line, properly insulated to keep the line from freezing, which could be constructed much more cheaply than any of the alternate methods.

The 12" steel water line is coated on the inside with Ricwilite phenolic resin for corrosion-resistance and covered with 3" thick Fiberglas insulation, with a ¾" steam tracer provided for stand-by use, if required. The entire prefabricated system is housed inside 21" diameter RIC-WIL HEL-COR Conduit, amply protected from the elements.

Consulting Engineer: Drury, McNamee & Porter, Ann Arbor, Mich.

Contractor: L. W. Brumm, Marquette, Mich.

RIC-WIL PREFABRICATED INSULATED PIPING — UNDERGROUND OR OVERHEAD

THE RIC-WIL COMPANY · CLEVELAND, O.

ONE CONTROL DOES THE JOB OF TWO

Mercoid DA-400 Series Pressure Controls incorporate a single bourdon tube which actuates two independently adjustable Mercoid magnet operated mercury switches to accomplish various circuit operations. For example:

1. Close one alarm circuit at high pressure and another at low pressure with both circuits open over operating range.
2. As an electrical interlock to open one circuit as pressure rises above and the second circuit as the pressure drops below operating range.
3. To provide two-stage control by opening or closing one circuit on a rise in pressure and the second circuit on a further rise in pressure.

Ranges 0-30" to 300-2500 psi

Write for Bulletin 5P

THE MERCOID CORPORATION
4201 BELMONT AVE. CHICAGO 41, ILLINOIS U.S.A.

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Power Conversion Units

A new eight-page bulletin on the complete line of General Electric metallic rectifier power conversion units has been announced as available from the company, Schenectady 5, N. Y.

Designated as GEA-5658B, the publication lists the design features, advantages, description, performance, circuits, dimensions, and ratings for the complete line, rated from 125 to 250 volts d-c. A guide is also provided as an aid in preparing contract specifications which entail GE d-c power supplies and exciters. Drawings show the outline dimensions of the power-conversion units.

Renewable Valve Seats

The Lunkenheimer Co. is offering a new descriptive circular showing sectional views of its complete line of Renewo Valves. The circular describes the dimensions and features of the Renewo line, which permits the interchanging of matched seats and disks for the easy conversion of valves from full-way to plug types. The seats and disks are renewable and regrindable.

Included in the circular are detailed views of the iron-bodied Ferrenewo and the bronze Renewo valves in globe and angle fullway and throttling types and in lift checks. Copies of Circular No. 577 may be obtained by addressing requests to The Lunkenheimer Co., Box 360-U, Cincinnati 14, Ohio.

Diesel Cylinder Deterioration

"Water Side Deterioration of Diesel Engine Cylinder Liners," eight pages illustrated, deals with problems in water cooling of Diesel engines, especially a "dynamic" pitting encountered in various services; marine, railroad, highway trucks, tractors, and cross country gas line compressor stations. Reasons are given for failure of protective measures to stand up in service, and certain steps are outlined that may be expected to provide effective remedies. Copies available from the International Nickel Co., New York 5, N. Y.

Wire Cloth, Filter Cloth, Fabricated Products

A new 125-page catalog, No. 50, contains full listings and illustrations of wire cloth, filter cloth, and fabricated products; an engineering design section, a research section, and a technical data section. The last three sections give it the value of a handbook. Highlighting Section IV is a report on 18 months of research into the flow characteristics and particle retentivity of metallic filter cloth, conducted at Columbia University in New York by special arrangement with Multi-Metal. The data contained in this report have never before been made available by a commercial firm. Available from Multi-Metal Wire Cloth Co., Inc., New York 59, N.Y.

Chemical Instruments

Bulletin CEC-1824 describes Consolidated Engineering Corp.'s Model 21-610 mass spectrometer, designed to monitor and control chemical manufacturing and refining processes, but claims additional versatility which enables it to serve as a leak detector or analytical mass spectrometer. Operation of the Model 21-610 is explained and illustrated. Consolidated's Chemical Instument Div. General Catalog covers the line of special-purpose mass spectrometers, and includes its leak detector, monitor of sulfur compounds in gases, micromanometer, electrical computer, high-speed digital tabulator of mass spectrometer data, and special service. Copies of these two publications are available from Consolidated Engineering Corp., 300 North Sierra Madre Villa, Pasadena 15, Cal.

Adjustable Loading Platforms

A four-page brochure, illustrating and describing its Adjust-a-Dock and Adjust-a-Truck is available from Rowe Methods, Inc., 2534 Detroit Ave., Cleveland 13, Ohio.

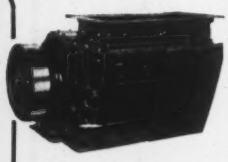
Both units are said to increase handling efficiency on shipping and receiving docks. The Adjust-a-Dock bridges the difference in height between docks and rail cars and highway trucks, so that goods flow directly to and from the building and the carrier. It can be installed recessed in the dock or in front of the dock as required.

The Adjust-a-Truck is designed for those firms who do not have adequate room on their docks or in front of their docks to install adjustable dock ramps. The unit is set into the pavement in front of the dock and by means of a heavy-duty electric hydraulic system, to adjust each vehicle to dock height. Its capacity is 40,000 lb.

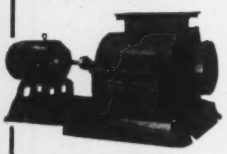
The brochure contains application photos, photos of main components, engineering drawings, specifications, operating and construction features, and other data.

FROM POUNDAGE to HIGH TONNAGE
AMERICANS Offer . . .
Precise Reduction

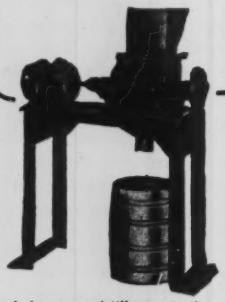
From small capacity laboratory mills to high tonnage mills, you can count on Americans to give dependable *uniform* sizing, and long, economical service. Americans are *custom-built* to handle specific reduction jobs *better*—your assurance of high efficiency, low-cost operation.



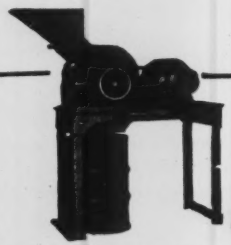
"30" Series Hammermill. Capacities to 100 TPH.



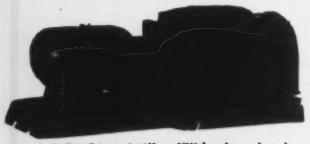
"24" Series—ring or hammer crushers. Capacities to 50 TPH.



Laboratory Mill—or testing pilot plant operation—and waste reduction.



"KC" Plastics Grinder—reduces thermoplastics sprues, rejects. Capacities to 450 lbs. per hour.



"AC" Ring Mill. With American's exclusive shredder rings—for high tonnage, uniform reduction. 500 TPH capacity.

Write for complete information on the American line of crushers

American PULVERIZER COMPANY
Originators and Manufacturers of Ring Crushers and Pulverizers
1541 MACKLIND AVE.
ST. LOUIS 10, MO.

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Industrial Fans

The Buffalo Forge Co. has published new bulletins on two Buffalo industrial fans. No. 3533-D covers design, capacity range, performance characteristics, and applications of Buffalo Tubeaxial and Vaneaxial Fans. Bulletins 3865 and FM-20 describe new Buffalo propeller fans now in 500-to 90,000-cfm capacities for ventilation systems with static pressures up to 1 in., in models for high or low temperatures, or corrosive atmospheres. The bulletins are available from Buffalo Forge Co., 148 Mortimer St., Buffalo, N. Y.

Flatness Measuring

The Crane Packing Co., 1800 Cuyler Avenue, Chicago 13, Ill. offers a six-page instructional bulletin, in color, illustrating and describing the measuring of surface flatness through light band reading. Interpretation of these readings is explained in detail. In addition this material provides instructions on the care and operation of monochromatic lights and optical flats and particulars on the company's line of precision measuring and lapping equipment.

The bulletin is so designed that when spread out it becomes an effective wall chart for quick and easy reference.

Lint-Free Textile Motors

Construction and application of the lint-free textile motor are described in a revised leaflet No. B-3515-A, available from the Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. Describing the motor's use as an individual drive for pickers, roving frames, winders, and spinning and twisting frames, this leaflet shows how special design of end brackets and air passages prevents clogging by lint or other dirt. To further insure nonsticking of lint, end windings are built up with a plastic filler and all surfaces are finished with a glossy coating of enamel.

Centrifugal Pump

Allis-Chalmers single-stage, double-suction centrifugal pumps, Type S, are described in a newly revised bulletin released by the company. The pumps, made in 66 standard sizes, individually engineered to customer specifications, are employed for general water supply, circulating, gathering, drainage, and other applications in the water utilities, paper, mining, petroleum, chemical, food, marine, and other industries as well as in power plants of all sizes.

In addition to providing data on the pumps' construction features, the bulletin explains how to figure pumping head, carries tables of available sizes, approximate dimensions, and head capacities, and tabulates friction loss for water per 100 ft of pipe.

Copies of the bulletin, "Allis-Chalmers Type S Single-Stage, Double-Suction Centrifugal Pumps," 08B6146B, are available on request from Allis-Chalmers Mfg Co., 949 S. 70th St., Milwaukee, Wis.

For Consulting Engineers
Turn to Page 138

Truck Scales

An eight-page two-color folder (Form No. 678) illustrates and describes the complete line of modern, heavy-duty Howe Four-Section Straight Lever Ball-Bearing Motor Truck Scales for weighing big truck and trailer loads. The folder reviews and illustrates many exclusive Howe features including ball-protected bearings, "inside" anti-friction plates, and other construction details. Installation photographs are shown.

Complete specifications and pit dimensions are listed. The Howe Four-Section Straight Lever Motor Truck Scale has a capacity of 50 tons. Platform sizes are 45, 50, or 60 ft long by 10 ft wide. The folder also describes the complete line of weight indication offered with these scales including: the Full-Capacity Beam, Type-Recording Beam, Balance Indicator, the exclusive Model 77-D and Cabinet Weightographs, the Tape-Drive Cabinet Dials, and the Howe Teleprint Electronic Remote Weight-Recorder.

For further information, write for a free copy of Form No. 678, The Howe Scale Co., Rutland, Vt.

Industrial X-Ray Unit

A new 4-page bulletin issued by the X-ray Dept. of General Electric Co., Milwaukee, Wis., gives specifications, basic designs, and a description of the G-E Resotron 250. This is a 250,000-volt industrial x-ray unit which is portable and lightweight.

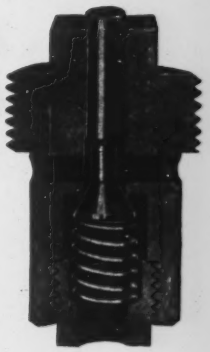
Welding Instruction Film Strips

A new series of film strips on arc welding for use by instructors to introduce students to the welding process, welding equipment, and where and how it is used is now available through The Lincoln Electric Co. of Cleveland, Ohio. The series of three strips, produced in full color and with a supplementary manual, is designed for instruction of high school students, vocational trainees, technical apprentices, and farmers, in the fundamentals of arc welding.

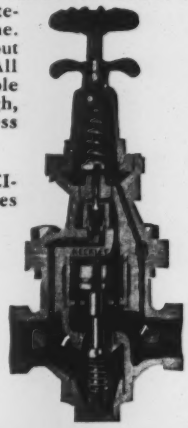
The series called *Arc Welding*, consists of three 50-frame strips: "Electric Arc Welding and How it Helps Man," "Selecting and Using Arc Welding Equipment Safely," and "Practicing Arc Welding." The series gives in full color photographs and art work a visual presentation of the historical development of welding, how the process works, what equipment is needed, and how it is used. Preliminary steps in making basic joints are illustrated with particular emphasis on safe welding practices. Close-up photographs of the welding arc in action show each step of how to hold and move the electrode as well as how to prepare and make welded joints in several welding positions. Sequences are designed to supplement and clarify class instruction and demonstration.

The strip was made by Lincoln Electric in cooperation with Audio-Visual Div., Popular Science Publishing Co. Conveniently boxed and with supplementary manual, the price is $19.50 for the set of three films.

UNIT PILOT VALVE
MAKES KECKLEY REGULATORS
EASIER TO SERVICE AND MAINTAIN



Here is a unique Keckley feature that means extra convenience and savings for you. The pilot valve can be removed as a unit. This means easy inspection, maintenance or replacement in a few minutes time. No bother with separate parts—comes out as easily as the spark plug in your car. All other parts of this valve are readily accessible too! All wearing parts are made of tough, long wearing, corrosion resistant stainless steel, further lowering upkeep.



Check into the Keckley line of PRECISION PRESSURE REGULATORS. Sizes ½" to 6"—pressure to 300 lbs. steam, 600 lbs. air, reduced to a low of 1 lb. Various combinations for pressure and temperature control. Ask our representative, your industrial distributor or write.

SEND FOR COPY OF COMPLETE CATALOG 53-D

- Float Valves
- Pressure Regulators
- Temperature Regulators
- Float Boxes
- Pop Safety Valves
- Strainers
- Level Controllers
- Diaphragm Valves

O. C. KECKLEY COMPANY
400 W. MADISON STREET CHICAGO 6, ILLINOIS

Manually Operated Chucks

Catalog No. 65-1952 describes the manually operated chucks manufactured by The Cushman Chuck Co. In addition to list prices for all chucks, each chuck is illustrated and complete dimensional data is furnished, to enable the purchaser to select the chuck to meet his requirements.

Acid-Proof Floors

An 8-page bulletin, "Rulon Acid-Proof Construction," describes the Rulon line of acid-proof floors and protective coatings. Asphalt mastic flooring compounds, for industrial floors and linings for sumps, tanks, trenches, etc., special flooring compounds for special conditions, acid-proof brick, and bituminous protective coatings are described in the bulletin, available from Ralph V. Rulon, 3900 No. 2nd St., Philadelphia 40, Pa.

Valves

A complete Digest of the Ohio Injector Co. General Catalog contains 24 pages of illustrations, valve listings, and information. All OIC valves are listed, along with sizes, trim, and end connections.

Information includes pressure-temperature and trim charts for cast- and forged-steel valves, and a chart for the selection of composition disks. There is also a section on valve accessories. The book is tab-indexed.

Traffic Controllers

A new two-color booklet, GEC-938, describing General Electric's Type F controller for traffic signal operation, gives design features, applications, operation, construction, specifications, and prices of the entire Type F controller line.

It also contains information on adjustable and fixed traffic signals and beacons. The bulletin is available from the company, Schenectady 5, N. Y.

Steam Specialties

A new catalog describing its complete line of regulating equipment for steam, gas, air, oil, and water has been issued by O. C. Keckley Co., 400 W. Madison St., Chicago, Ill. The new catalog includes complete specifications, operational data, and prices on the Keckley line of pressure regulators, temperature regulators, combination pressure and temperature regulators, diaphragm valves, motor-operated valves, float valves, pop safety and relief valves, strainers, solenoid and motor valves, and water gages.

Capacity tables are presented to aid in and to simplify the selection of proper-sized regulators for a variety of steam, water, and air services. There are also flange charts, a table of steam pressures and corresponding temperatures, and a table of water heads and equivalent pressures.

Instrument Gages

A new 24-page bulletin has been released by the Taylor Instrument Companies. It describes the latest development in 6-in. dial indicators for temperature, pressure, and load applications.

For temperature instruments, a variety of sensitive elements or bulbs are explained and the recommended applications for each are given. Mounting dimensions for the different types of instruments are also included. Free copies of Bulletin 98214 are available from Taylor Instrument Companies, Rochester 1, N. Y.

Condenser Tube Inserts

A new 4-page bulletin describing Wilson condenser tube inserts has been announced by Thomas C. Wilson, Inc., Long Island City, New York.

The bulletin declares that condenser tubes usually fail in the first few inches of the inlet. Wilson inserts, the bulletin says, restore these leaking tubes to service by sealing off the deteriorated portion of the tube, and also retard or eliminate the effect of the inlet end erosion.

Copies of this new Wilson Bulletin 500 are available from Thomas C. Wilson, Inc., 21-11 44th Ave., Long Island City 1, N. Y.

Fixed-Displacement Hydraulic Pumps

A new Brochure A-5206 has been prepared by Vickers Inc., describing their line of 34 standard sizes of fixed-displacement hydraulic pumps. Featured on the cover of this brochure is a presentation which points up the saving available to a user when an accessory with a very high overall efficiency is used. Vickers has spelled this out in the case of a 10-gpm pump size and indicated that for each 5 per cent overall efficiency loss within a hydraulic pump, the cost to the user can be converted into the following representative factors for each 1500 hr of operation: 194.3 gal fuel, 1165.5 lb of payload, or $66.00 cost of fuel.

The new Vickers Fixed-Displacement Pump brochure can be had by writing to Vickers Incorporated, 1400(59) Oakman Blvd., Detroit 32, Mich.

Vacuum Cleaning System

Billmyre Blower Div. of Lamson Corp., Syracuse, N. Y., has developed a new 20-page 2-color booklet giving complete information on the Lamson Exidust central vacuum cleaning system. Diagrams as well as photos are used to describe this industrial and commercial cleaning system. Exidust picks up dirt, dust, and small particles by means of a flexible hose and attachments and passes them through a stationary piping system to one or more collector separator tanks. An integral exhauster and motor unit provide the required vacuum. Following basic engineering information, the booklet describes uses and names representative users. Design features and details are clearly presented. Sufficient engineering data is included in the bulletin to make it possible for the reader to plan his central vacuum cleaning system in complete detail, down to the last cleaning tool.

DESIGN, DEVELOPMENT ENGINEERS...

Looking for the *right* change?

Many men are—and the *right* job is often mighty hard to find.

But we've got some interesting openings now at Honeywell that might represent the right change for you.

If you're an experienced engineer it would pay you to look into the openings we now have in six areas:

- Servomechanisms
- Vacuum Tubes
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Duties of the jobs. Take on complex design work requiring analysis and decision to bring into design form the requirements for a new or modified instrument, device or control system.

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Atmosphere. A company that understands engineering—where one out of every ten employees is actively engaged in engineering or research.

Openings. In Minneapolis, Philadelphia and Freeport, Illinois.

For details write Mr. Ross Wagner, Personnel Dept., ME-5-87, Honeywell, Minneapolis 8, Minn. Ask for our book, "Emphasis on Research."

MINNEAPOLIS **Honeywell**

First in Controls

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Slitting Lines

The Yoder Co., 5500 Walworth Ave., Cleveland 2, Ohio, has published the third edition of its catalog of multiple rotary slitting lines, a 76-page illustrated book. Part I contains basic information on design, selection, and operation of slitters and slitting lines, including time studies, an analysis of the operating cycle, and a discussion of coil-handling and scrap-disposal methods. Part II contains specifications, capacity tables, and other data on the Yoder standardized series of uncoilers, slitters, recoilers, coil cars, and scrap choppers. A subject index concludes the catalog.

Industrial Lighting

The latest and most elaborate of a series of "See Better—Work Better" bulletins, designed to promote improved lighting in the nation's industrial plants, has been issued by General Electric's Lamp Division. Bulletin No. 8, an eight-page illustrated publication in full color, describes what it calls the "revolution in industrial lighting." This revolution, it states, is based on the concept of balanced brightness, as well as sufficient light, over the entire work area. Benefits are listed as better workmanship, faster output, reduced spoilage, fewer accidents, and improved employee morale. Available from the Inquiry Bureau, General Electric Co., Nela Park, Cleveland 12, Ohio.

Cold-Worked Steel Bars

"Your Blueprint to New Economies in the Use of Steel Bars—Stressproof" is a 12-page pamphlet published by the LaSalle Steel Co., Chicago 80, Ill., describing "Stressproof" severely cold-worked furnace-treated steel bars. Properties, sizes, ladle analysis, finish, and tolerances for size ranges are listed.

The applications of "Stressproof" steel bars are emphasized, and the manufacturer claims that many parts now made from carbon and alloy carburizing or heat-treating steels can be successfully produced from "Stressproof" cold-finished carbon-steel bars. The use of "Stressproof" to eliminate case carburizing, reduce straightening, and increasing machining rates are discussed. A list of applications and a table of average comparative steel properties concludes the booklet. Copies are available from the manufacturer.

ENGINEERING MANPOWER COMMISSION OF ENGINEERS JOINT COUNCIL AND ENGINEERS COUNCIL FOR PROFESSIONAL DEVELOPMENT COOPERATING TO:

ENCOURAGE OUR YOUTH to CONSIDER the OPPORTUNITIES in ENGINEERING & SCIENCE

FOR INFORMATION WRITE TO: ENGINEERING MANPOWER COMMISSION 29 W. 39th ST., NY 18, NY

DESIGN IDEA CUTS PRODUCTION COST 50%

SIMPLE replacement of heavy cast covers with welded steel units effects an 80% reduction in weight on elevator machine covers at The Shepard Elevator Company, Cincinnati, Ohio. At the same time, manufacturing cost is 50% less. These direct savings result from less material and elimination of machining required on former castings.

Weight reduction is particularly important on this equipment since elevator machines are usually mounted on upper floors of multi-story buildings. Easier handling within the manufacturer's own plant as well as lower shipping charges further add to lowering total costs.

In manufacture, it was originally necessary to mill the bottom edge to form an oil-tight seal. This entire operation is now eliminated. The complete unit is manufactured within the shop and without dependence on outside sources for castings.

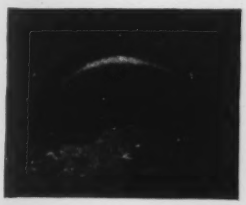

Fig. 1. Original construction of gear case cover weighed 66 pounds and required milling of bottom edge for oil-tight seal with gear case.

Fig. 2. Steel designed gear case cover now used weighs only 10 pounds and costs half as much to produce. Fabricated entirely within manufacturer's own shop by welding.

Fig. 3. Assembly of cover on gear case. Cover is 16 gauge sheet metal welded to plain angles forming oil-tight seal with main gear case.

How to Design in Welded Steel

Send for latest design bulletins. Write on your letterhead to Dept. 4803.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND 17, OHIO
THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Automatic Controls

A General Catalog on Photoelectric and Electric Controls for counting, registration, segregation, timing, and liquid level control is offered by Photoswitch, Inc., Cambridge, Mass. Descriptions of controls are contained in the catalog, with applications, installation instructions, and specifications. "Cutting Production Costs With Electronic Controls," Bulletin PG4910, discusses the uses of photoelectric and electronic controls in 45 different cases in nontechnical language. The case studies are indexed by industries.

Sump Cleaning

Sump cleaning with vacuum equipment is the subject of a new Bulletin No. 130-C recently published by The Spencer Turbine Co. of Hartford, Conn. This equipment can pick up liquids at the rate of 40 gpm, with a tank capacity of 125 gal.

Recently improved vacuum equipment for picking up water from floors, ducts, etc., is also described. This equipment may be connected direct to a Spencer Vacuum Cleaning System or may be provided as a portable unit with capacities up to 8 gal.

Compressors and Centrifugal Pumps

The Pennsylvania Pump & Compressor Co., Easton, Pa., has published a 6-page condensed listing of its compressors and centrifugal pumps and accessory equipment, with bulletin numbers for further information on each item.

Gas compressors, oil-free air and gas compressors, steam-driven gas compressors, steam booster compressors, tandem compressors, duplex compressors, dry vacuum pumps, air cushion valves, aftercoolers, and centrifugal pumps are covered.

Mill Motor Flexible Couplings

Flexible couplings designed for use in steel mills, on cranes, shovels, bridges, and other installations where starting or shock loads are encountered are described in Bulletin 54, from the Ajax Flexible Coupling Co., Inc., Westfield, N. Y. Dihedral teeth, exclusive with Ajax, permit more misalignment capacity and less backlash, the manufacturer declares.

Tables of maximum parallel-offset capacity for couplings designed to accommodate angular misalignment, dimensions of couplings, standard mill motor shaft dimensions, and keyway specifications are included in the 4-page bulletin. Ajax Dihedral Couplings are equipped with Johns-Manville Clipper Seals, utilizing neoprene sealing elements.

Steam Accumulator

Bulletin RA-52-8 describes the action of the Foster Wheeler Corp. steam accumulators, discussing their principle of operation, capacity calculation, and theory. The advantages claimed for the steam accumulators are: (1) they reduce required boiler capacity from that sufficient to meet all peak loads to that required only to supply the average demand; (2) they increase boiler efficiency by enabling the boiler to be operated at the rating corresponding to maximum efficiency continuously; (3) they insure constant pressure because the accumulator accommodates sudden increases in steam demand; and (4) a wide range of capacities is available: installations capable of storing 220,000 lb of steam have been made.

Power Control Systems

A new folder illustrating several new power control installations has been published by Panellit, Inc. Included in the folder are data and illustrations of central control boards, boiler auxiliary controls, turbine control panels, and details of their application to specific power stations.

One installation shown is an electronic combustion control system, claimed to be one of the most complex ever installed, which incorporates television for direct viewing of remotely located boiler gages. Also shown is a unique bench board arrangement which integrates a wiring trench with a walk-way below the floor. Copies of Bulletin 3010 are available upon request to Panellit, Inc., 6312 N. Broadway, Chicago 40, Ill.

EVERY STEP A SAFE STEP WITH BLAW-KNOX GRATING

Everyone walks safely, confidently on Blaw-Knox Electroforged Steel Grating . . . the one-piece panels stay rigid and strong—without shimmy or shake—because there are no parts to work loose. Twisted cross bars provide sure footing under the most adverse conditions. For complete information, write for Bulletin 2365.

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Industry's first choice for
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• LOW UPKEEP • SELF-CLEANING

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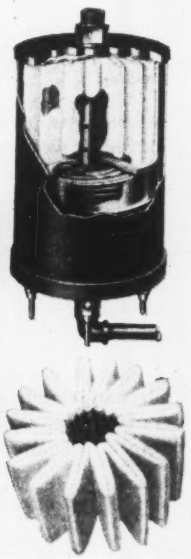
BLAW-KNOX ELECTROFORGED STEEL GRATING

—for "INSTRUMENT-QUALITY" AIR IN COMPRESSED AIR OPERATIONS . . .

HERE'S YOUR ANSWER!

HANKISON MODEL B-30-D *Condensifilter*



Featuring the New-Economical DISPOSABLE FILTER CARTRIDGE

Dehydrate and filter ordinary plant air with a Hankison Model B-30-D Condensifilter for air of "Instrument-Quality." Condenser section removes moisture by lowering dew point of air to within 2 or 3 degrees of cooling water; low cost, disposable filter cartridge with 540 sq. in. of surface area removes even finest dirt particles. Capacity: 30 scfm at 100 psig.

Write for Bulletin B-30-D
For larger capacities, write for data on Model A-100.

HANKISON CORPORATION

353 Biltmore Building 951 Banksville Road
PITTSBURGH 16, PA.

SEE THIS TINY HOLE

IN THIS TINY TUBE?

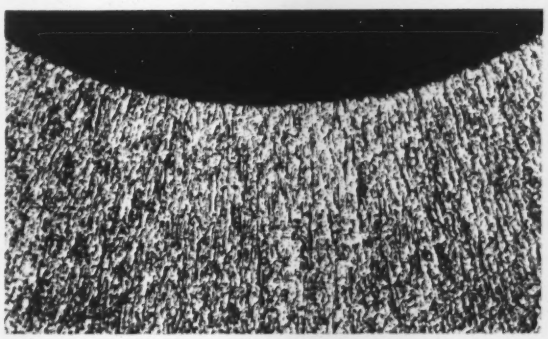
It is plug drawn

By being plug drawn, the tube is endowed with an inside surface of exceptional, mirror like smoothness. Thus the flow it provides is uniform, and uninterrupted, and high efficiency in operation is attained.

THIS DISTINCTIVE TUBE IS CALLED

*Capilator**

the capillary tube used for restriction purposes



The accompanying photomicrograph, showing a 200-time magnification of the inside wall of the Capilator, gives you a good idea of the smoothness of this inside surface. The size of the tube shown was .081" O.D. x .031 I.D.

*REG. U. S. PAT. OFF.

When you attend the Inform-A-Show in Los Angeles May 24-27, be sure to visit our Booth 304

It is to your great advantage to learn more about Capilator—indeed an exceptional capillary tube.

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.

Manufacturers of Tubing Exclusively

1437 CENTRAL AVENUE • DETROIT 9, MICHIGAN

ESTABLISHED 1916

Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

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Other Wolverine Products

CAPILATOR*
—the capillary tube for restriction purposes
COMMERCIAL TUBE
AUTOMOTIVE TUBE
CONDENSER TUBE
COPPER WATER TUBE (K-L-M)
ELECTRIC WELDED STEEL TUBE
FABRICATED TUBULAR PARTS
WOLVERINE TRUFIN*
—the integral finned tube
REFRIGERATION AND AIR CONDITIONING TUBE
(Plain or Tin Plated)
S.P.S. PIPE
SPUN-END TUBE†

*Reg. U.S. Pat. Off.
†A Patented Process RE 22465

Why you can *lower inspection costs*

with a Kodak Conju-Gage Gear Checker

Why the composite check

The composite check recommended in American Standard B6.11-1951 tests gears functionally by running the gear against a master of known accuracy. The resulting displacement shows at once the cumulative effect of as many as six types of error—eliminates time-consuming checks for each individual error. The check is rapid and conclusive.

Why the Kodak Conju-Gage Gear Checker

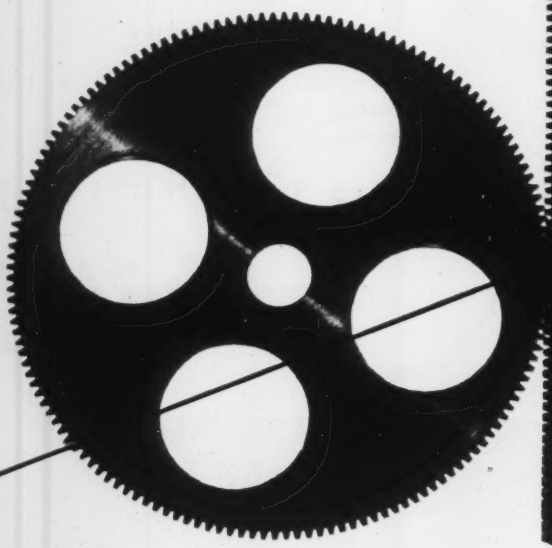
To meet today's tolerance requirements, the Kodak Conju-Gage Gear Checker uses a master made with a new order of precision. This is the Kodak Conju-Gage Worm Section, produced by thread grinding under control of a precision lead screw.

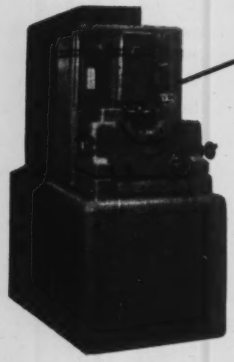
The accuracy inherent in this method means every right gear is passed by the worm section, reducing rejection losses. The transverse curvature produced by this method provides a master that can be used to check any gear of like pitch and pressure angle, regardless of helix.

Not only can a single worm section be used in place of a number of circular masters, but such a worm section can be reground to specification as often as necessary—at a fraction of replacement cost. It is easily checked for accuracy by familiar toolroom procedures.

You can find out more about the economies possible through Kodak Conju-Gage Instrumentation by sending for a copy of the booklet, "Kodak Conju-Gage Gear Testing Principle." Write to:

Industrial Optical Division
EASTMAN KODAK COMPANY
Rochester 4, N. Y.





The Kodak Conju-Gage Gear Checker automatically records the composite effects of runout, base pitch error, tooth thickness variations, profile error, lead error, and lateral runout. Illustrated is the Kodak Conju-Gage Gear Checker, Model 4U, for gears up to 4½" pitch diameter. Larger and smaller models are also available.

CONJU-GAGE INSTRUMENTATION

... a new way to check gear precision in action

To inspect all kinds of complex parts on a bright screen, Kodak also makes two highly versatile contour projectors.

Kodak

Where continuous flow and maximum capacity are required, use

ZURN DUPLEX GATE-TYPE L-P-D PRESSURE DROP STRAINERS

Free Floating Valve Disk, easily removed through the valve access cover, insures against binding of valve operating mechanism.
Hinged Cover with "C" Washer Closure and Multiple Basket design facilitates cleaning; permits one man operation.
Operating Screw cannot be damaged by corrosion or foreign particles in the liquid on the inside or by physical damage on the outside of the strainer.
Large open area ratio (6 to 1) lengthens cleaning cycle relative to conventional style 2½ or 3½ to 1 open area ratio strainers.
Angle Basket design permits straight-through flow, minimizes pressure drop.

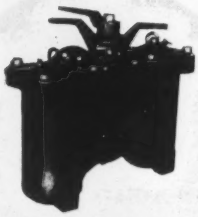
● Design improved for placement of Multiple Catch-Baskets. *This permits straight-through flow which minimizes pressure drop.* Angle Basket design insures complete retention of strained particles when basket is being removed for cleaning. *One man can complete basket cleaning easily, rapidly and at low cost.* Basic face-to-face and centerline-to-base dimensions are favorable for installation in minimum space.

Like all other Zurn LPD Strainers, Duplex Gate-Type Strainers are held at close tolerances for materials, shapes and dimensions assuring the utmost in strength and safety and continuous operation.

Zurn LPD Strainers are widely used to protect close tolerance control devices and delicate mechanisms, also to protect product purity. Zurn LPD Strainer applications include fluid handling lines for lubricating and fuel oil, and oil during the refining process; a wide range of chemicals produced and used by the various process industries; public utility power plants; power stations; industrial plants and ships. They are available for high temperature and high pressure installations. Zurn Fluid Handling Engineers are available for consultation. Write or wire direct to factory.

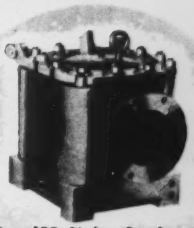
J. A. ZURN MFG. CO.
INDUSTRIAL DIVISION
ERIE, PA., U. S. A.
In Canada: Canadian Zurn Engineering Ltd., Montreal 25, P. Q.

There is a ZURN LPD strainer for every fluid handling purpose


Zurn LPD Duplex Strainer, Plug-Type

Zurn LPD Sinlox Strainer available in offset and straight-through types.

Zurn LPD "Y" Type Strainer available in any cast material and for high pressures.

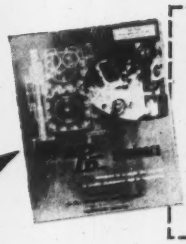

Zurn LPD Sinlox Strainer, Multiple Basket type, available in several metals and for high temperature installations.

(Zurn Engineered Low Pressure Drop Strainers are patented and patents pending.)

Copyright 1953

WRITE FOR ZURN LPD STRAINER DATA MANUAL NO. 952

This Manual includes *previously unpublished pressure drop data* and gives useful, factual information on fluid handling.



J. A. ZURN MFG. CO. • INDUSTRIAL DIVISION • ERIE, PA., U. S. A.
Please send me Zurn LPD Strainer Data Manual No. 952.

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Position .....
Company .....
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City and State .....
Please attach coupon to your business letterhead—Dept. ME.

24 ACRES *Cover the World*

. . . with TOP QUALITY

DROP FORGED STEEL

VALVES, FITTINGS and FLANGES

by

Vogt

Air View of
Henry Vogt Machine Co.

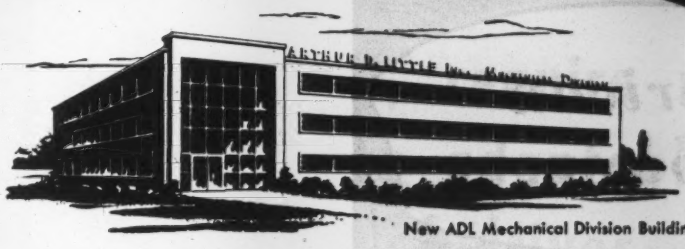
This 24 acre Vogt plant supplies the most comprehensive line of top quality *drop forged* steel piping materials anywhere available to industry. That's why they're the choice of leading refineries, power plants, chemical plants, etc., the world around!

OUR COMPLETE LINE INCLUDES

Flanged, Screwed and Socket Weld End Globe, Gate and Check Valves • Ells, Tees and Crosses • Couplings • Bushings • Plugs • Unions • Flanges and Flange Unions • Welding Heads

HENRY VOGT MACHINE CO. LOUISVILLE 10, KY.

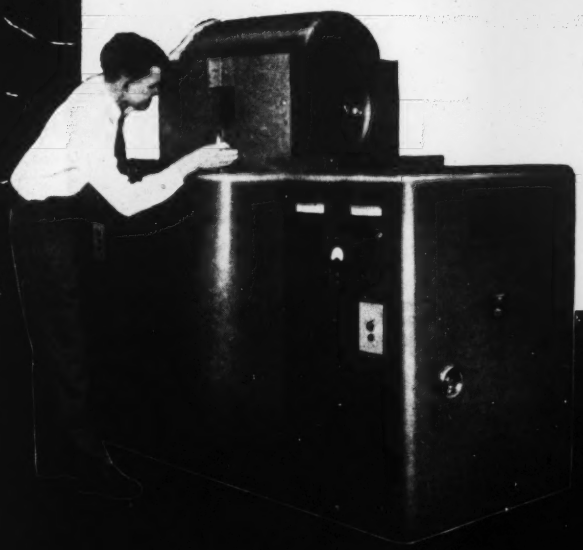
Branch Offices: New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va.



New ADL Mechanical Division Building

for advanced engineering techniques . . .

UNIQUE PROTOTYPE DEVELOPMENT



The ADL Electromagnet is one example of unique electrical prototype development. It represents creation and development of a prototype unit to supply magnetic field strengths of a magnitude normally requiring magnets of five times greater size and weight. The versatility, functional features and performance of the ADL Electromagnet as a basic research tool has contributed to the advancement of science.

If lack of personnel has halted development of your new ideas or new products, the ADL Mechanical Division can take over and bring them to complete maturity.

Arthur D. Little, Inc., has blended its scientific and engineering skills in the Mechanical Division to provide industry with a unique service . . . prototype development of equipment requiring a high level of engineering. Scientists in the fields of chemistry, physics, metallurgy, mathematics, biology, electronics and technical economics can be called on as required.

Our staff is experienced in interpreting the ideas of industry and following through with the perfection of specialized equipment.

THERMODYNAMICS • HEAT TRANSFER • REFRIGERATION TO MINUS 456 F • VACUUM ENGINEERING • GAS LIQUEFACTION • ELECTROMAGNETISM • MECHANICAL DESIGN • VIBRATION

Write for Brochure ME 17-1

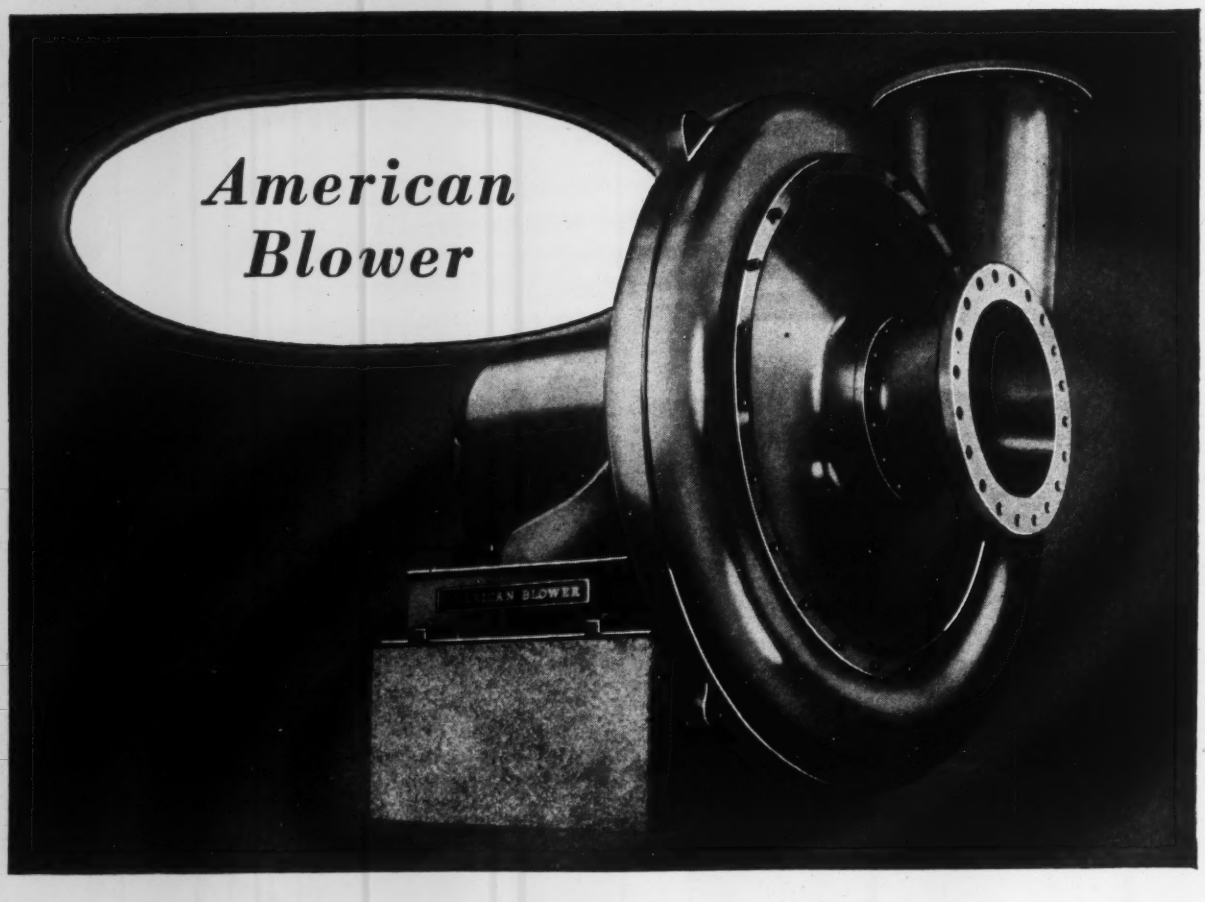
MECHANICAL DIVISION

Arthur D. Little, Inc.

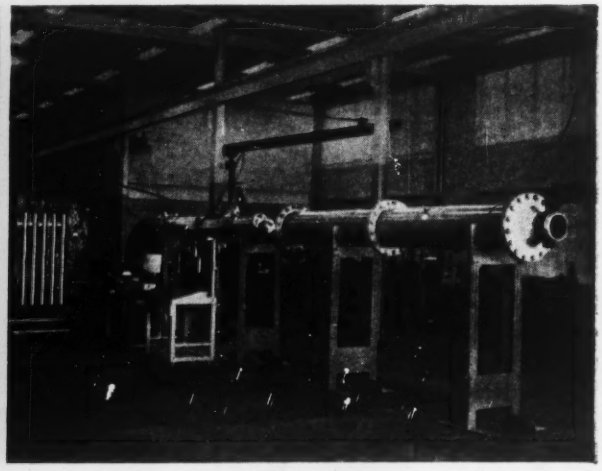
CREATIVE TECHNOLOGY SINCE 1886

ADL Mechanical Division

30 MEMORIAL DRIVE, CAMBRIDGE, 42, MASS.



Centrifugal Compressors



Prior to shipment, each compressor is thoroughly tested for mechanical and performance characteristics in accordance with the A.S.M.E. Power Test Code in American Blower's modern research and testing laboratory.

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS

They're compact, require minimum foundations, are adaptable to all types of drives

Use Them Profitably for These Jobs

AIR COMPRESSION
ANNEALING FURNACES
CATALYST REGENERATORS
COAL PULVERIZATION
CUPOLAS
CYCLONE FURNACES
FORGING FURNACES
GAS BOOSTERS AND EXHAUSTERS
LEAD AND COPPER FLOTATION
PNEUMATIC CONVEYING
OIL-GAS GENERATORS
PLANT PRESSURIZING
SINTERING
WATER-GAS GENERATORS

American Blower Single Stage Centrifugal Compressors are basically variable-volume, constant pressure compressors, built to deliver efficiently large volumes of air or gases at high pressures.

You can buy them in sizes from 30 to 600 HP with pressures from 1¼ to 3¾ lbs. In addition, any American Blower Centrifugal Compressor can be equipped with controls to meet specific job requirements — such as constant inlet volume, constant suction pressure, constant discharge pressure, or constant weight flow.

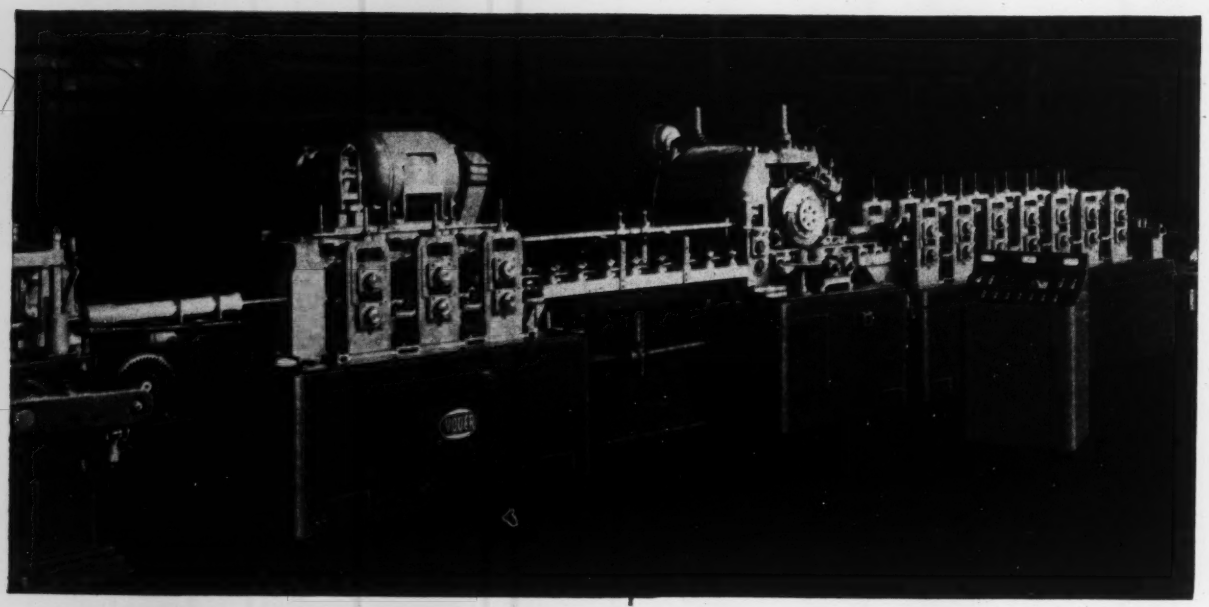
For technical data, consult the nearest American Blower Branch Office or write us for Bulletin 109.

Whether you need equipment for heating, cooling, ventilating, air conditioning, vapor absorption, fume removal, dust collecting, mechanical draft, heat transfer or smooth power transmission thru Gyrol Fluid Drives — American Blower manufactures a complete line of products to meet your requirements. Helpful technical literature is available on each product.

AMERICAN BLOWER

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

& WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS



Highest Output of

Quality Tubes

● Most manufacturers, when investing in an electric-weld tube mill, do so only after careful investigation, especially of performance records. Where, as often happens, records are available of the output and scrap losses of different mills, making comparisons possible, the choice of a Yoder is never in doubt. As a result, since their introduction in 1938, more Yoder mills have been installed in the U.S.A. and many foreign countries than electric-weld mills of all other makes combined.

In fact, the high quality and economy of tubing made in Yoder mills, have powerfully stimulated consumption and multiplied the uses for electric-weld tubing in the automotive, electric appliance, metal furniture and other mass production industries. The supply of such tubing, therefore, has never caught up with the demand.

Get the facts about Yoder mills, incorporating the latest developments in tube making, including the revolutionary new Yoder high speed induction welders for *non-ferrous as well as ferrous metals* and alloys.

THE YODER COMPANY
5499 Walworth Ave. • Cleveland 2, Ohio

Complete Production Lines

- ★ **COLD-ROLL-FORMING and auxiliary machinery**
- ★ **GANG SLITTING LINES for Coils and Sheets**
- ★ **PIPE and TUBE MILLS–cold forming and welding**

ENGINEERING YODER MANUFACTURING

Time and Again it's Kellogg

...when reheat is the order!

WHY KELLOGG . . . particularly for reheat piping systems? There appear to be several factors responsible, all derived directly from the fundamentals of the reheat systems themselves.

Naturally, the *double* intake and exhaust turbine leads complicate these piping layouts . . . the higher temperatures employed increasing the need for accurate determination of stress and reaction values and the extra-careful positioning of restraints. Designers frequently have found Kellogg's unique model tester of considerable help in solving these problems. With it, they can pinpoint stress and reaction values and line deflections, change proposed layouts to meet their findings, and retest . . . *all in a matter of hours rather than days or even weeks.*

Then the elevated temperatures, which make these reheat systems economically attractive dictate the use of alloy steel piping. Here, utility company engineers well realize that experience and meticulous production methods are essential for fault-free installations. Kellogg's experience has two-fold interest to these purchasers.

First, Kellogg has specialized in high-temperature, high-pressure power piping for more than three decades, has installed the alloy main steam piping for more than 6¼ million KWS of output. During this period the company has in many cases led the way with research work to determine the most desirable steel analyses, bending and welding methods, heat treatment techniques and quality controls.

Second, in the field of alloy fabrication, Kellogg fabricated the first stainless power installation, establishing the heating cycles for welding and post-welding treatment . . . set the specs for the welding electrodes. Add to this innumerable other alloy piping installations in all branches of industry, including a current job for the AEC which alone involves the installation of over 25,000 tons of piping.

The total of this specific experience, when combined with active, continuous research and development work pointed toward further improvements in materials and fabricating techniques . . . are the basic reasons why **"Reheat power piping by Kellogg"** is so often the specification . . . *36 times within the current power expansion period.*

OTHER FABRICATED PRODUCTS including: Pressure Vessels . . . Vacuum Vessels . . . Fractionating Columns . . . Drums and Shells . . . Heat Exchanger . . . Process Piping . . . Bends and Headers . . . Forged and Welded Fittings . . . Concrete and Radial Brick Chimneys

These leading companies are among the many major producers of power who use

M. W. KELLOGG POWER PIPING . . .

- Consolidated Edison Co. of N. Y.
- Consumers Power Co.
- Detroit Edison Co.
- Dow Chemical Co.
- Elektricitetsselskabet Isefjordvaerket (Denmark)
- Ford Motor Co. of Canada Ltd. (Canada)
- General Electric Co.
- Hartford Electric Co.
- Houillers Du Lorraine (France)

FABRICATED PRODUCTS DIVISION
M. W. KELLOGG

KELLOGG — SUBSIDIARY OF PULLMAN INCORPORATED

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HIGH TEMPERATURE
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POWER PIPING

VACUUM METALLIZING...

"More and more use is going to be made of this remarkable process", said exhibitors at the 1952 Metal Show.

"Working in a DRY atmosphere greatly speeds up pulling the vacuum", reports Canadian Motor Lamp Company.

THE PROCESS: Metal or plastic parts are placed in a sealed retort. A high vacuum is pulled and aluminum wire is vaporized by an electric current. This deposits on the parts, giving 85% reflective power, compared to 62% for polished aluminum.

THE PROBLEM: Moisture in the air and on the parts being metal coated slows down the pulling of a vacuum, cutting production and increasing costs.

THE SOLUTION: DRY the air with a Lectrodryer* as Canadian Motor Lamp Co., Ltd. do at their Windsor, Ont., plant. They report that it would be impossible to maintain their high production schedule and turn out such quality workmanship without this DRYing help.

Names of companies making equipment for this high vacuum coating of metals and plastics will be supplied to you on request. Where DRYing is indicated for the air surrounding this equipment, or for air supplied to their retorts, Lectrodryer will work with them to give you most efficient, economical operation.

For further information, write to Pittsburgh Lectrodryer Corporation, 335 32nd Street, Pittsburgh 30, Penna.

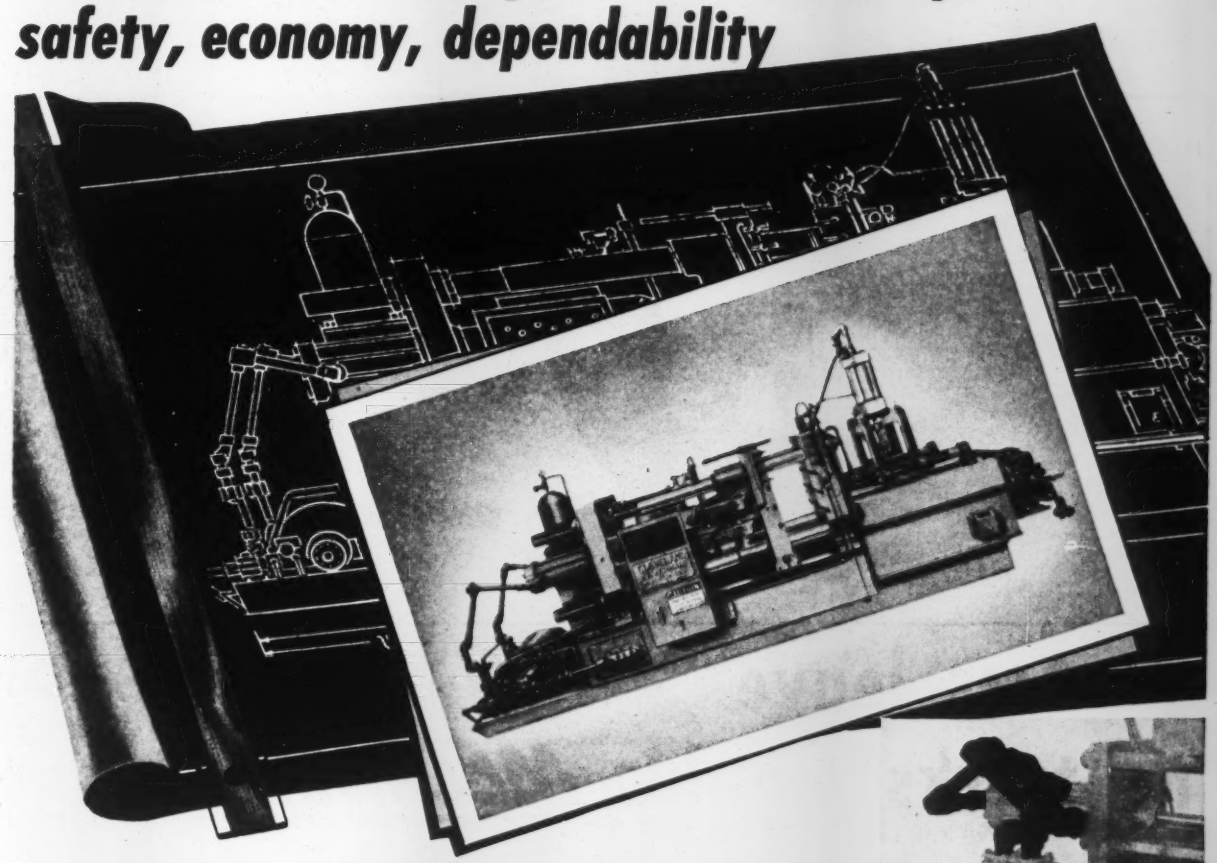
In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U. S. PAT. OFF.

CHIKSAN has a blueprint for flexibility, safety, economy, dependability



CHIKSAN speeds the flow of industry when

THE DIE IS CAST

BY CLEVELAND AUTOMATIC

When industry wants better castings, faster, for lower cost it turns to the Cleveland Automatic Machine Company to furnish high pressure hydraulic die casting equipment. Cleveland is an old hand in making dependable machines that turn out precision castings to keep the wheels of industry humming.

Cleveland, in turn, relies on Chiksan Ball-Bearing Swivel Joints and Chiksan engineering to supply the flexibility, safety, dependability and economy needed in handling high pressure hydraulic oil—transforming metals to essential parts for industry's forward march.

• • • •

The whole range of industry looks to Chiksan to supply a blueprint for progress in the better, safer, more economical task of conducting liquids and gases through freely flowing lines—under great extremes of temperature and pressure—in the most difficult or complex manufacturing conditions and procedures—with uninterrupted flow—with low maintenance—with precision and profit.

• High Pressure (Chiksan) Ball-Bearing Swivel Joints on the die locking end permit adjustment of die space and insure a leakproof hydraulic system.

• High Pressure (Chiksan) Swivel Joints are standard equipment in hydraulic lines of all hot chamber machines to allow for adjustment of the shot cylinder assembly and at the same time eliminate all fire hazard.

• (Quoted from the manual that Cleveland has issued about the Model 400 Die Casting Machine—emphasizing importance of Chiksan Ball-Bearing Swivel Joints.)

The Flow of Enterprise Relies on **CHIKSAN**

Ball-Bearing Swivel Joints

CHIKSAN TRADE MARK REG.

Representatives in Principal Cities
Write for Catalog 2A, Dept. ME-5

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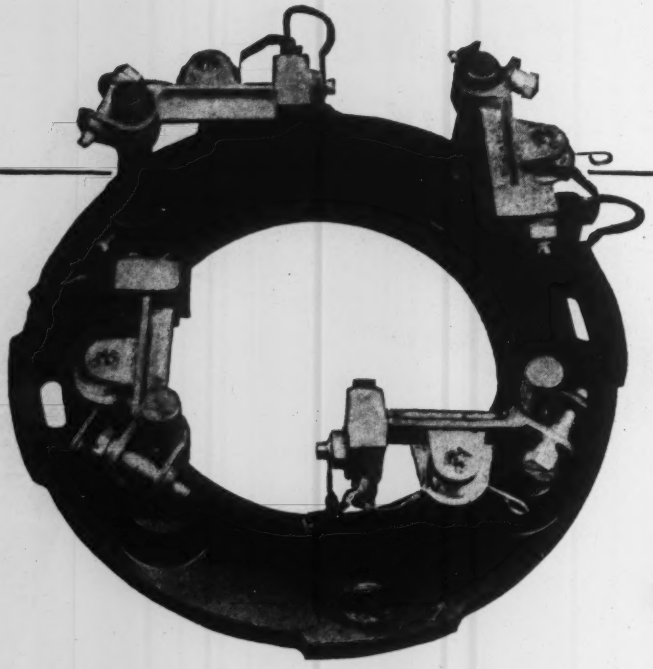
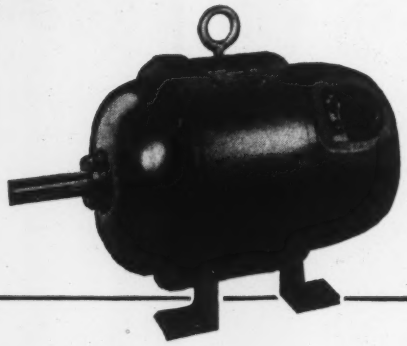
Weil Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J.



SK DEPENDABILITY



Arcs leave no tracks on this *MELAMINE* ring

When conducting dust collects across the surface of a rocker ring, it can cause a flashover. In the case of ordinary materials used for rings, this arc carbonizes a path into the ring itself. Thus, when the machine is cleaned to remove conductive particles, the path or track cannot be removed. High resistance grounds result. Motor efficiency is lost.

But, carbon flashovers don't have a chance on this Melamine ring. It's arc proof... noncarbonizing. There is no tracking effect . . . no "burned-in" paths to cause shorts. Thus, when you wipe the ring clean, it is restored to full service condition. Top motor efficiency is maintained.

That is one reason why the Life-Line SK offers users of d-c motors new dependability. Cast brass brushholders are another. They are noncorroding . . . have no bearings to wear or bind. No moving parts to get out of adjustment. A stainless steel spring maintains perfect brush contact through constant tension.

There are other reasons, too. Ask your Westinghouse representative to show you the inside story of the Life-Line SK motor. See the "Transvision" presentation. It takes the SK apart and puts it together again at your own desk. You'll see why something new has been added to SK dependability. Call your local representative today. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-21555-A

YOU CAN BE SURE...IF IT'S

Westinghouse

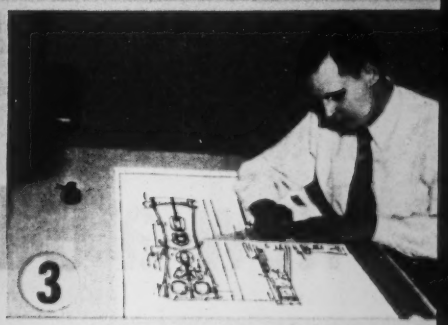
Simple 1-2-3 operation beats the five o'clock deadline

At the Symington-Gould Corporation, Depew, N. Y., extensive revisions are made on drawings of railway specialty equipment... and prints are ready for mailing to customers—hours, even days, ahead of the old schedule.

See how it's done—all so easily—with Kodagraph Repro-Negative Paper . . . another versatile photographic material in the famous Kodagraph line.

A basic drawing—which must be revised to meet the customer's specifications—is exposed on Repro-Negative Paper in a standard print-making machine; then the print is processed in standard photographic solutions. *An easy room light operation* that produces a negative photographic intermediate from the original drawing.

The draftsman obliterates the unwanted detail on the Kodagraph Repro-Negative print by simply applying opaquing ink. The way Symington-Gould figures it, when large areas must be revised . . . or many small scattered changes must be made, this is easier, faster than altering a positive print.



A positive Repro-Negative print is made from the corrected negative . . . on this the draftsman adds the new design . . . and a master is ready to produce the required number of prints. *Ready* in a fraction of the time required previously when the unchanged design was retraced in full.

These Kodagraph Materials also save Symington-Gould time and dollars

- Kodagraph Autopositive Paper is used to reclaim old, soiled drawings; to produce intermediates from customer-drawings on opaque stock.
- Kodagraph Contact Cloth is used to reproduce corrected negative prints when durable, inklike cloth intermediates are desired.
- Kodagraph Autopositive Cloth is used to reproduce new pencil drawings directly, which helps eliminate costly ink tracing.

NOTE: Kodagraph Autopositive Paper and Cloth are processed in the same easy manner as Repro-Negative Paper, but produce positives *directly* from the originals.

Kodagraph Reproduction Materials

"THE BIG NEW PLUS" in engineering drawing reproduction.

Get the full story on the sensational Kodagraph line; learn how you, or your local blueprinter, can process these materials at surprisingly low cost. Write today for a free copy of "Modern Drawing and Document Reproduction."

MAIL COUPON FOR FREE BOOKLET

16

EASTMAN KODAK COMPANY
***Industrial Photographic Division*, Rochester 4, New York**

Gentlemen: Please send me a free copy of your illustrated booklet, "Modern Drawing and Document Reproduction."

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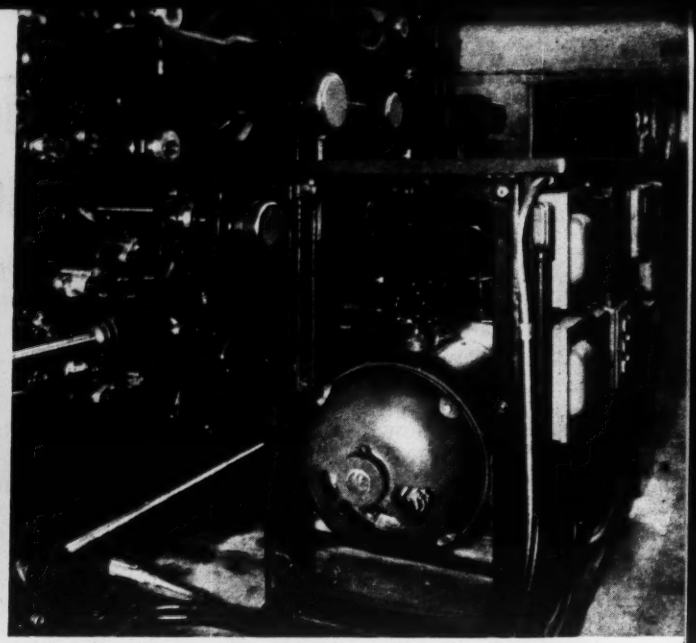
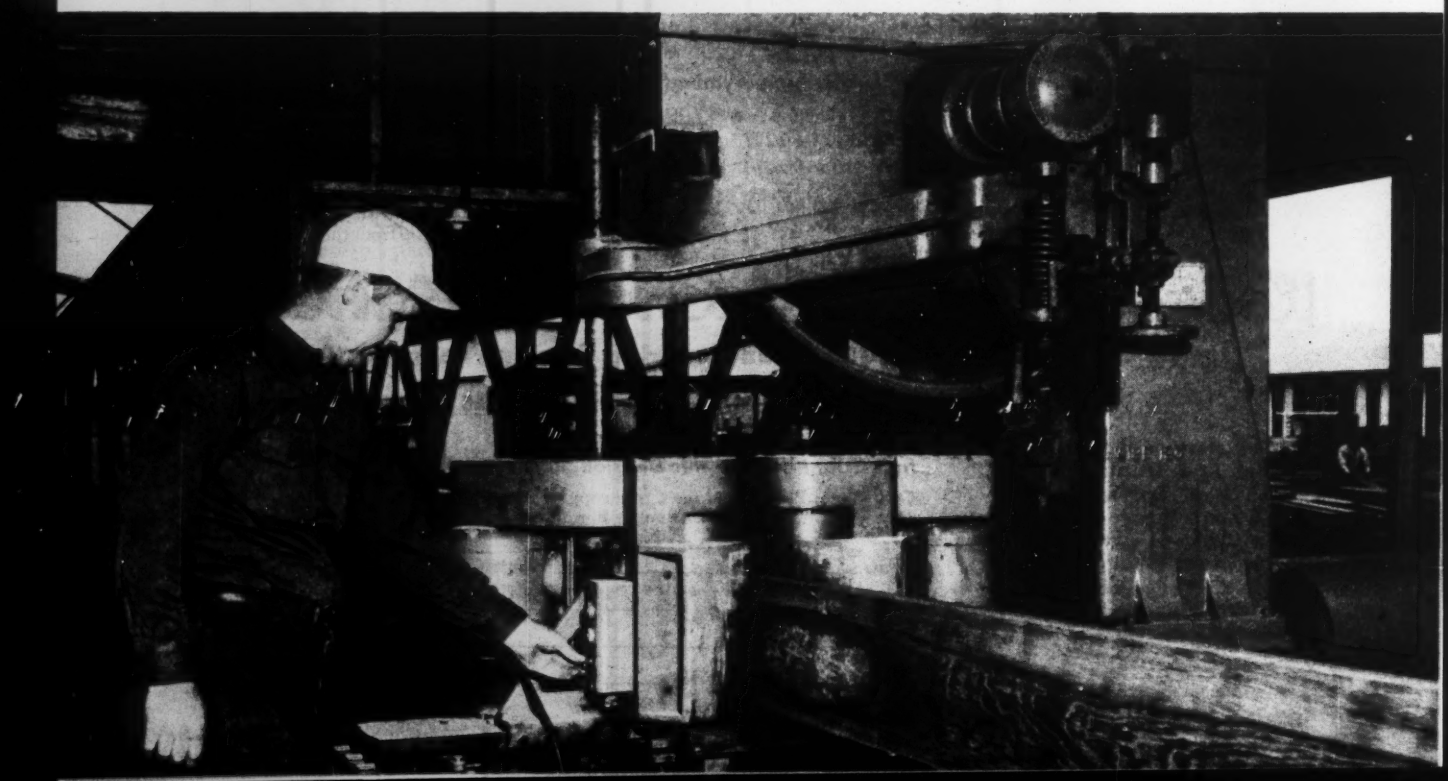
Kodak
TRADE MARK

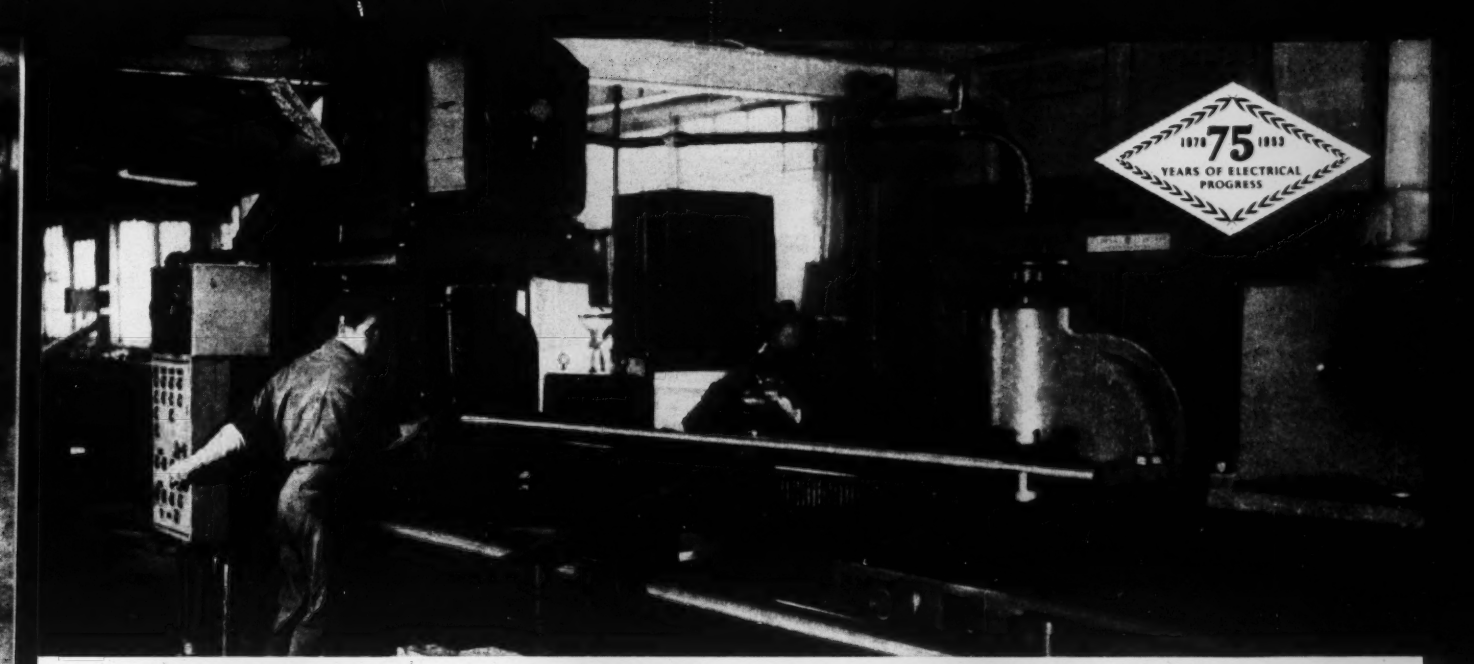


G-E ACA MOTOR as applied on a monotype casting machine in the plant of the Los Angeles Examiner (left) and as the main drive on a five color press in the plant of the Kansas Color Press, Lawrence, Kansas. The G-E ACA motor is your simplest and most economical electrical adjustable-speed drive. You get stepless speed adjustment directly from AC power over a 3 to 1, 6 to 1, and 20 to 1 range. No external conversion equipment is necessary. For additional information, check the coupon for Bulletin GEA-4883.

How a G-E Adjustable-speed Drive

G-E THY-MO-TROL® DRIVE at the San Jose Lumber Sales and Milling Company, San Jose, California, enables the operator to vary the speed of the resaw feed roll from 8 ft. to 250 ft. per minute. G-E Thy-mo-trol Drive can be made to hold speed regulation as close as ± ½%. It is available between 1/40 and 75 horsepower and offers smooth, stepless speed adjustment ranging up to 100 to 1. G-E Thy-mo-trol is easy to install, maintain, and operate. For complete information, check Bulletin GEA-5337 in the coupon at right.





TWO G-E SPEED VARIATORS, one of which drives the cutter-head and the other the bar-feed on this installation at the Allegheny-Ludlum Steel Co., Watervliet, N. Y. G-E Speed Variators are available in ratings from 1 to 200 hp, with excellent speed regulation and in speed ranges up to 40 to 1. With the addition of an amplidyne or electronic regulator, the Speed Variator will give you even closer speed regulation. The packaged power unit is easy to maintain, easy to move to new locations. Ask for Bul. GEA-5335 and 36.

can increase your production!

G-E ADJUSTABLE-SPEED DRIVES mean accurate, stepless motor speed control . . . the chance to improve the versatility of your present machinery . . . increase your production. With a G-E Adjustable-speed Drive you can reduce waste . . . improve product quality.

G-E ADJUSTABLE-SPEED DRIVE WILL ENABLE YOU to produce a greater variety of goods . . . for with the flexibility of adjustable motor speeds you can greatly diversify your product output. Fundamental speed adjustment is available from the G-E ACA motor which is controlled by a simple twist of the dial . . . precise speed control can be obtained with the G-E Thymo-trol drive or Speed Variator. Whatever your need, there is a General Electric Adjustable-speed Drive for you . . . packaged drives are available from 1/40 to 200 hp . . . speed ranges from 3 to 1 up to 100 to 1.

TO GET COMPLETE INFORMATION consult your nearest General Electric Apparatus Sales Office. Your G-E Sales Representative will be glad to recommend the most economical drive best suited for your operation. For printed information on the complete line of G-E Adjustable-speed Drives, use the coupon.

**Reg. Trademark of the General Electric Company.*

You can put your confidence in—

GENERAL ELECTRIC

LET G.E. HELP YOU PICK THE RIGHT DRIVE

Because only General Electric makes **all major types** of electric adjustable-speed drives, it is best qualified to help you select the **right drive.** Send for these informative bulletins.

☐ **A.** This 26-page manual describes **all** four types of drives and where to apply them. Bulletin GEA-5334.

☐ **B.** Lower cost, simplest a-c drive. Bulletin GEA-4883.

☐ **C.** More flexibility, moderate cost. Bulletin GEA-5335.

☐ **D.** Top performance, 1/40—75 hp. Bulletin GEA-5337.

☐ **E.** Top performance, 1–200 hp. Bulletin GEA-5336.

General Electric Company
Section D 646-23
Schenectady 5, N. Y.

Please send me the bulletins checked
☐ for reference only
☐ for planning an immediate project

NAME .....

COMPANY .....

ADDRESS .....

CITY ..... **STATE** .....

TERRY

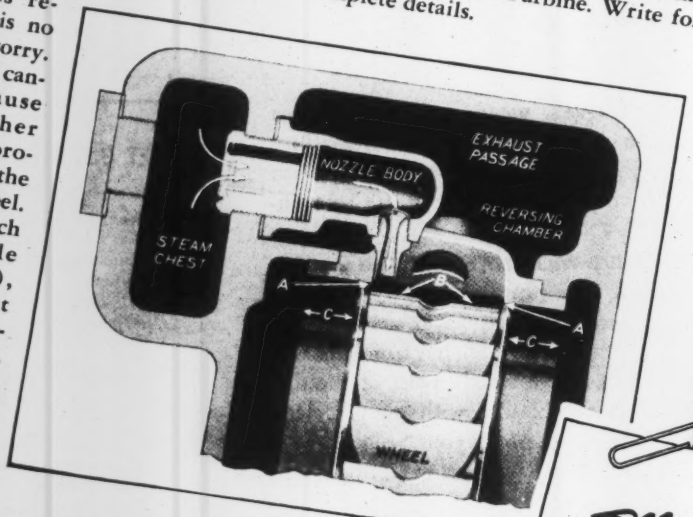
LARGE CLEARANCES take the "worry" out of Turbine Operation

In a Terry Solid-wheel Turbine the power-producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets. This unique design permits unusually large blade clearance—see B in the diagram.

Even if this clearance becomes reduced, there is no real cause for worry. The blades still cannot foul because they are further protected by projecting rims at the sides of the wheel. These rims, which also have ample clearances (AA), will take without damage any rubbing that may occur.

Side clearance, CC, is so large that end-play from external thrust will not damage the wheel. This clearance is one inch or even greater.

Large side and blade clearances are only two of the many features of the Terry Solid-wheel Turbine. Write for complete details.



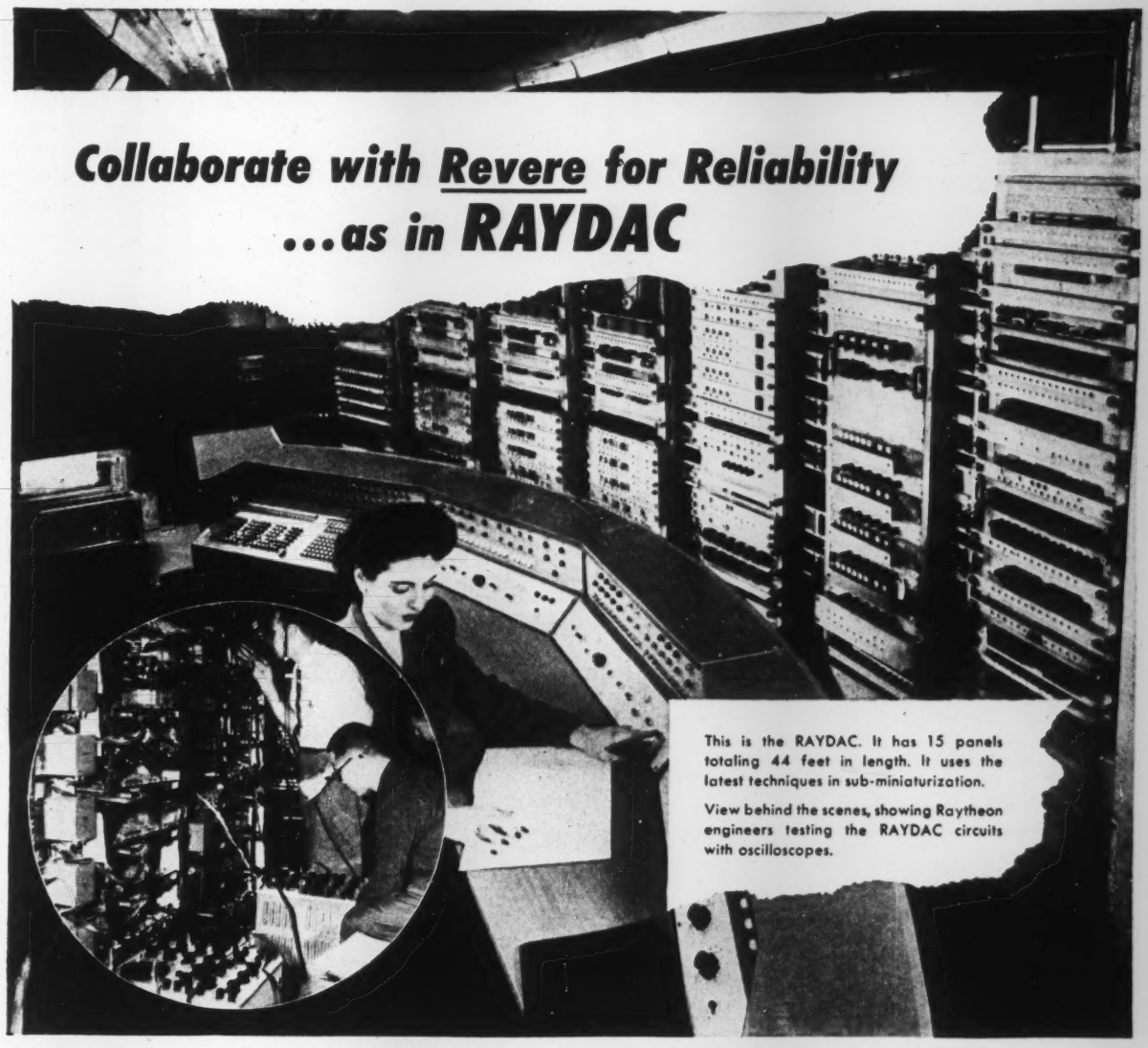
THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1191

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

Collaborate with Revere for Reliability ...as in RAYDAC



This is the RAYDAC. It has 15 panels totaling 44 feet in length. It uses the latest techniques in sub-miniaturization.

View behind the scenes, showing Raytheon engineers testing the RAYDAC circuits with oscilloscopes.

RAYDAC means Raytheon Digital Automatic Computer, developed by the Raytheon Manufacturing Company, Waltham, Mass., for the Navy's Bureau of Aeronautics. It is an "intelligence center" to help analyze the behavior of missiles during test flights. Its importance is indicated by the fact that in a matter of minutes it can perform the calculations involved in analyzing a single missile flight, a task that would take a team of mathematicians from 20 to 30 days. The Raydac thus speeds up tremendously the development and testing of such missiles. It contains enough tubes and germanium diodes made by Raytheon, for more than 1,000 home radio sets.

In such a complicated electronic computer reliability is essential. This is achieved through design, the choice of the best materials and components, and meticulous manufacture. Revere during the past 10 years has collaborated closely with Raytheon, working out proper specifications for materials, as for example, OFHC copper. Raytheon engineers and production men have visited Revere laboratories at New Bedford, Mass., and Rome, N. Y., and many Revere specialists have studied methods and processes in the Raytheon plants and laboratories. These hand-in-glove contacts, many of them highly confidential, have proved their value.

The same kind of collaboration is open to you, and will be especially useful and time-saving if begun as soon as you have a new project on your boards. To obtain it, simply get in touch with the nearest Revere Sales Office. See your telephone book or write direct.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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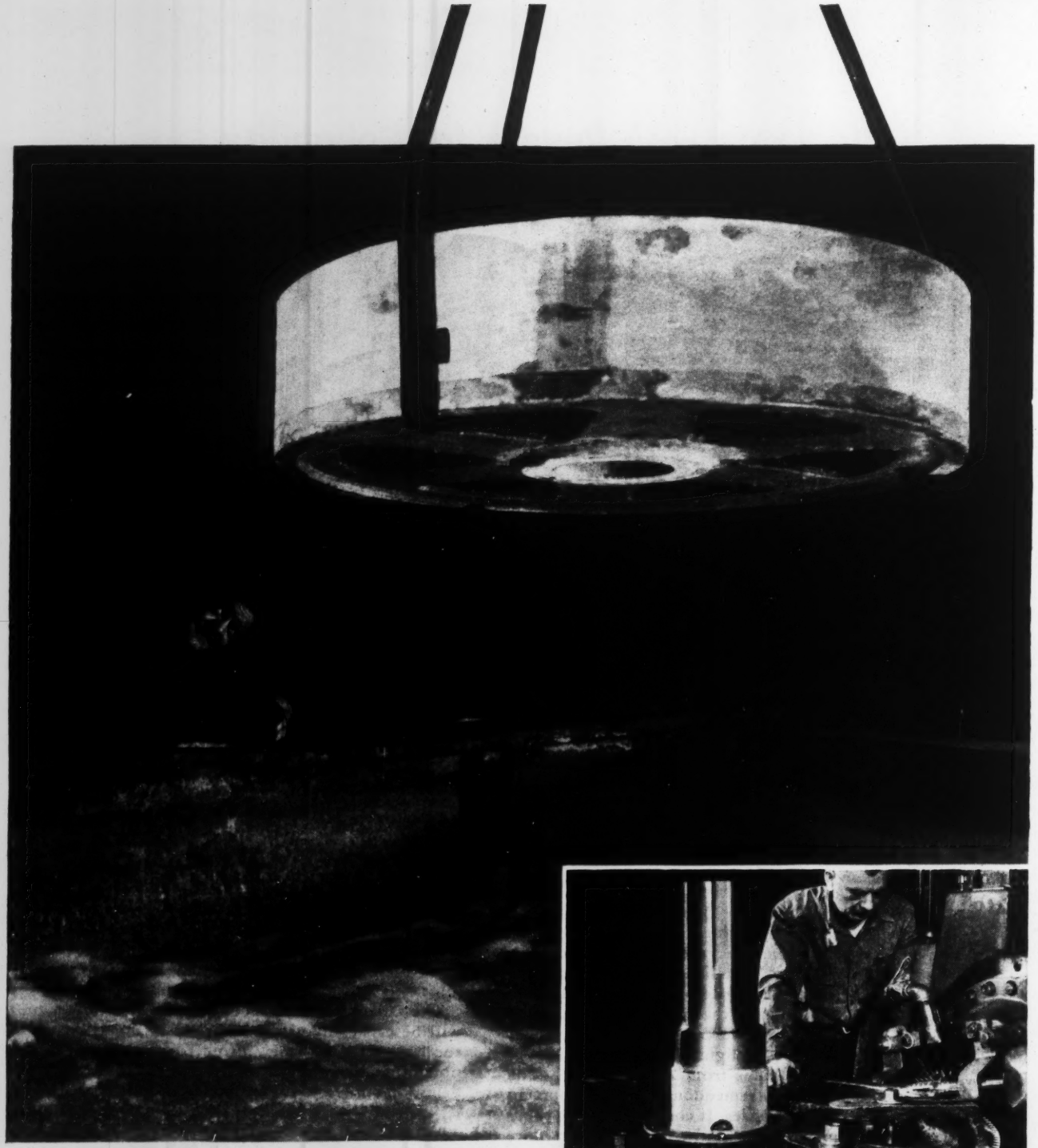
Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere

SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY



After heating, **all Westinghouse Gear Blanks receive this quenching in an exclusive BPT solution. Gears so processed have a tapered hardness from surface to core—absorb the shocks of everyday service.**

The hobbing process, **long recognized as one of the most accurate of gear-cutting methods, is used on gears for all Westinghouse Speed Reducers. It assures true gear meshing and quiet operation of the finished speed reducers.**

Do your speed reducers have the added value this precise manufacturing assures?

Are you getting toughness, stamina, long life? These are qualities of Westinghouse Speed Reducers which stem from the step-by-step precision that goes into their making.

Westinghouse Gear Blanks, for instance, are made from high-quality steel that's thoroughly checked for conformity to specifications. Gears are hob cut which means precision cut. They're heat-treated by an exclusive Westinghouse BPT process that carefully tapers gear hardness from surface to core. It's your assurance of gear teeth that will resist surface wear yet absorb the many shocks of service.

Antifriction bearings on all Westinghouse Speed Reducers lessen friction loads—especially on starting. They maintain precise gear center distance. The result —permanent alignment and minimum friction loss.

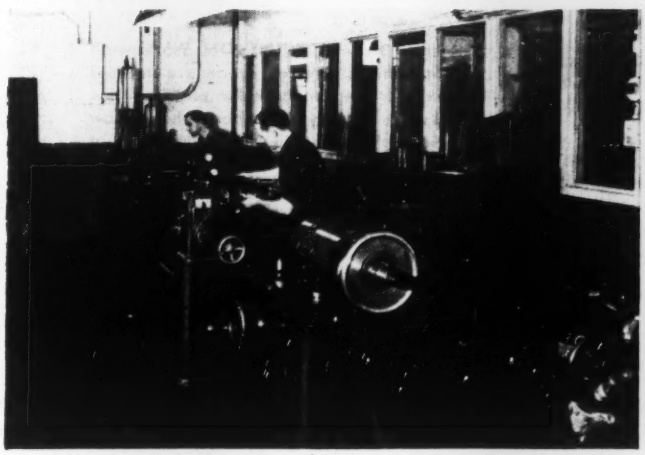
The rugged cast iron gear case is made in two sections for ready accessibility of all working parts. Thus servicing is greatly simplified. Ribbing, provided at points of greatest stress, gives extra strength and rigidity with proper alignment of parts maintained at all times.

These features, together with many others that are designed, manufactured and tested to meet rigid Westinghouse standards, are the result of over sixty years' experience in the design and manufacture of gearing. This adds up to speed reducers that give year-in, year-out, trouble-free performance. Investigate the full line of Westinghouse Gearing Equipment wherever speed reduction is required. Your local Westinghouse representative will be glad to furnish any information. Call on him at any time or write, Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

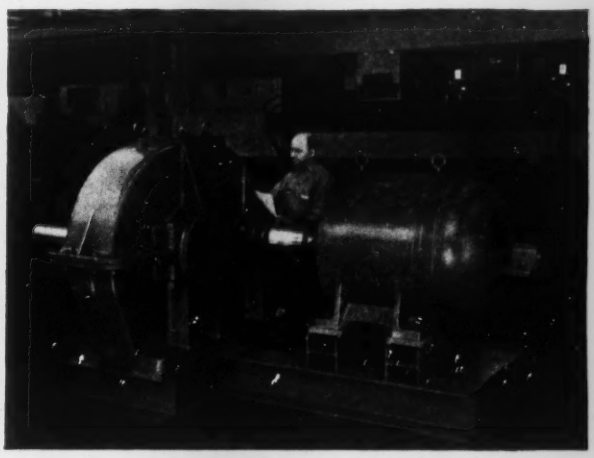
J-07332

YOU CAN BE **SURE**...IF IT'S

Westinghouse



All machined parts are thoroughly inspected at each step of manufacture to assure the high degree of accuracy necessary for smooth operation. Hobs and other tools are also checked repeatedly to control uniformity of gears produced.



Before shipment, each complete speed reducer is given a running test under load. These tests enable Westinghouse to determine in advance the performance of each unit under conditions approximating actual service.

Putting Air to work for Sharp & Dohme: Germ-free air is essential. Just "fresh air" won't do in the world's largest plasma plant.

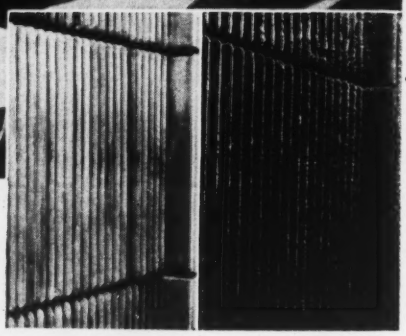
6000 MILES AWAY

PURE AIR FIGHTS BATTLE SHOCK

A wounded soldier's life depends on an early transfusion. But whole blood is perishable, and liquid plasma needs special storage. So dried plasma is used because it keeps its life-giving qualities for five years. That's why Sharp & Dohme's blood processing is so important—it accounts for over one third of today's output.

This operation is so delicate that just "fresh air" would contaminate precious plasma. To keep air at its highest purity, Sharp & Dohme uses Westinghouse PRECIPITRON®, the electronic air cleaner. Five PRECIPITRON units work 'round the clock to remove dirt and germs.

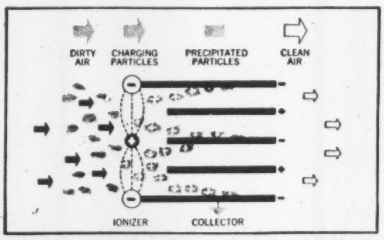
You can *put air to work*, too. Westinghouse has the equipment to handle it. For data on air cleaning, air handling or air conditioning products, ask for Catalog 600. Call your local Westinghouse-Sturtevant office. It's listed in the Yellow Pages. Westinghouse Electric Corporation, Sturtevant Division, Hyde Park, Boston 36, Mass.



CLEAN PLATES DIRTY PLATES

Here's How PRECIPITRON Works—All dirt particles in the air stream are charged and attracted to collector plates of the opposite polarity. The above photos show how much dirt is collected in 2½ weeks of cleaning "fresh air".

The PRECIPITRON is the most efficient air cleaner available commercially for removing impurities from normal air.



WESTINGHOUSE AIR HANDLING

The Armed Forces need blood. *Give a pint today!*

YOU CAN BE SURE...IF IT'S **Westinghouse**

J-80291

Oh, I see

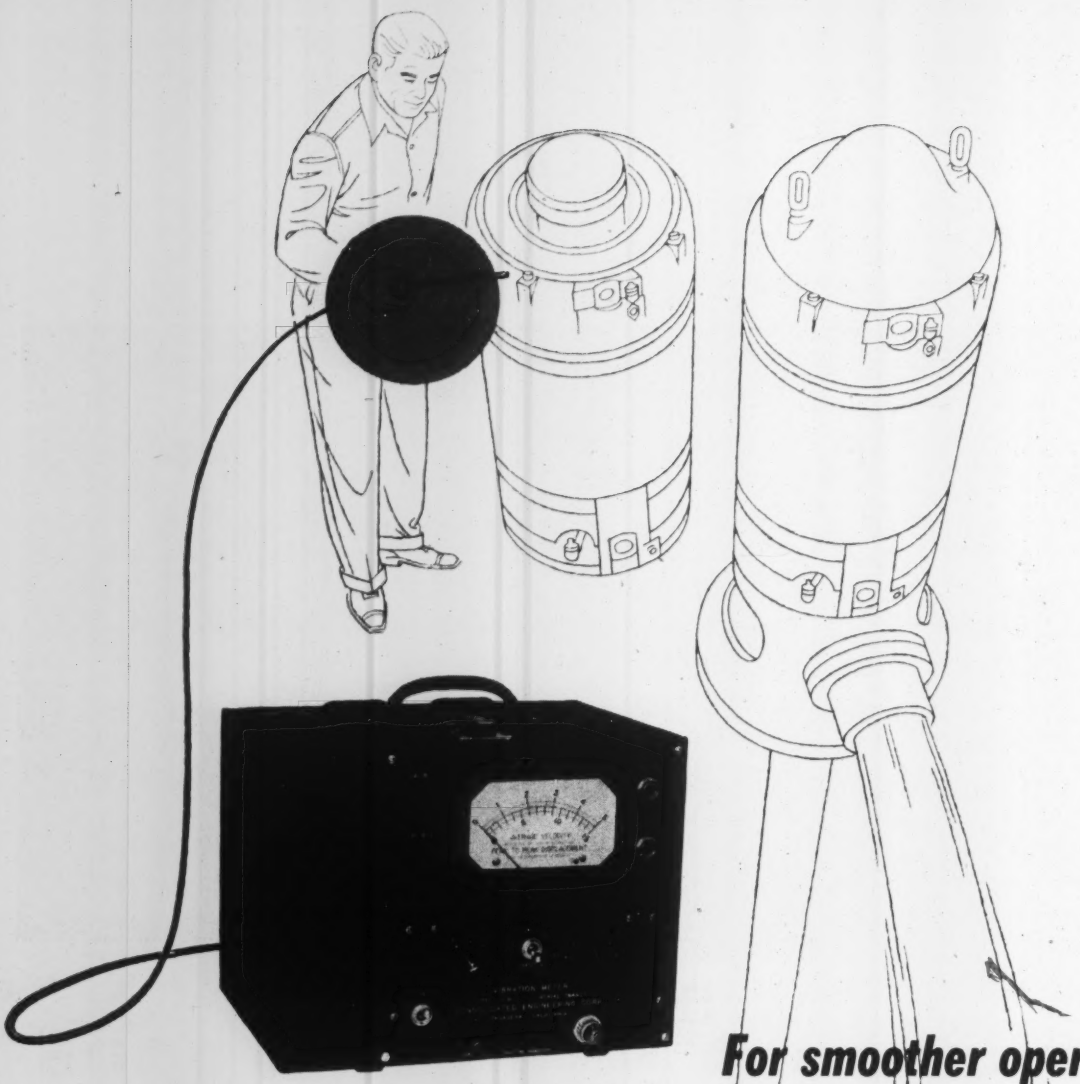
. . . they're using our valves at Riegel Carolina . . .

OIC iron valves, steel valves, bronze valves—you see hundreds of them all through this amazing new plant of the Riegel Carolina Corporation near Acme, North Carolina. The OIC Long Line of Valves—proved dependable in years of similar service—enabled Piping Equipment Company of Greensboro, North Carolina, to meet every kind of flow problem in this pulp mill.

OIC FOUNDED 1881

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

VALVES . . . FORGED & CAST STEEL, IRON & BRONZE



For smoother operation and longer life

EVERY MOTOR at U. S. Electrical Motors, Inc., is checked for dynamic balance before being placed in service. Vibration elimination, important in all motors, is vital to the satisfactory performance of vertically mounted motors that drive deep-well pumps. Their high centers of gravity magnify and transmit any imbalance through long vertical shafts to submerged pumps. To prevent damage to motor, shaft and turbine impellers, every U. S. Verticlosed motor is pre-checked with Consolidated instrumentation. Vibration monitoring is a profitable practice, paying off in greater customer satisfaction. If vibration elimination would improve your process or your product, our long experience in the field of dynamic measurement can help you.

Consolidated Engineering
CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

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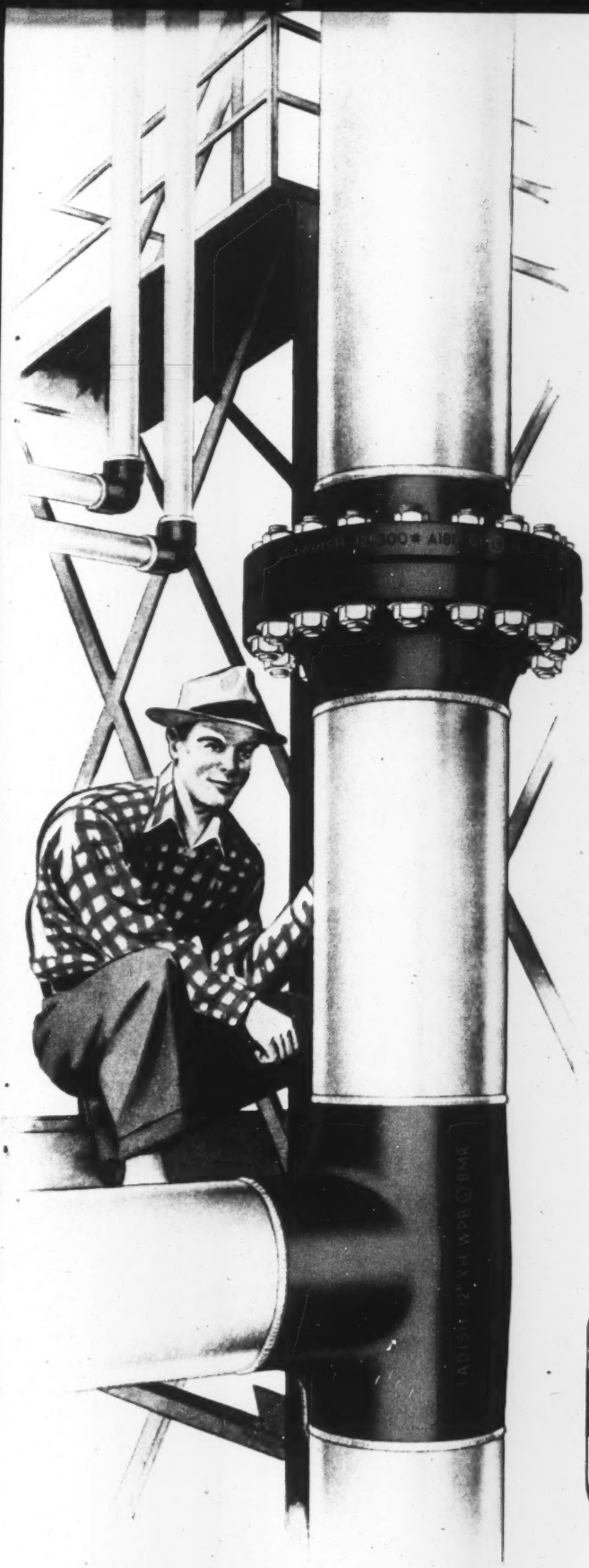
Vibration Meter—and Vibration Pickup, a simple, effective dynamic measuring combination. Consolidated makes many types of transducers, amplifiers, bridge balances and recording oscillographs for use in science and industry. Write for CEC Bulletin 1505B-X4.



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PIPE FITTINGS

maximum service assured by metallurgical soundness

Sound metallurgy . . . the result of unsurpassed facilities and advanced laboratory controls . . . provides the maximum of dependability in Ladish Controlled Quality fittings. Every phase of metal quality . . . composition, structure and physical properties . . . is continuously safeguarded — and certified proof of metallurgical integrity is available to users of Ladish fittings.

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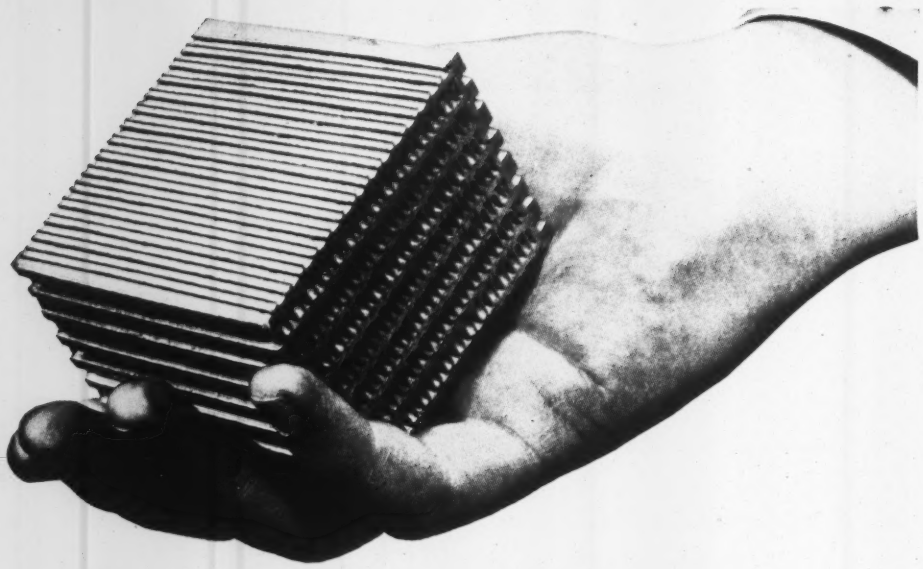


This sample section of a TRANE Brazed Aluminum Heat Exchanger shows how its construction can pack up to 450 sq. ft. of surface into a single cu. ft. of space.

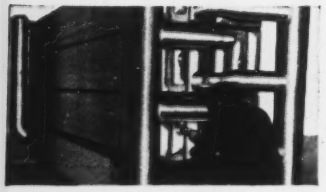
Is this your key to a new product or process?

New TRANE Brazed Aluminum Surface makes NEW products and processes not only possible...but practical. Here's why:

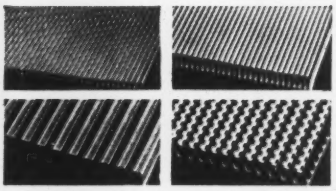
1. Wider range of core sizes and shapes.
2. Greater variety of surfaces.
3. Almost unlimited design flexibility.
4. Up to 9 times more surface for the heat exchange job than with conventional ¾" shell-and-tube construction.
5. Light weight. Yet takes test pressures up to 1,000 lbs. per sq. inch and temperatures from −300° to 500° F.
6. Can handle 5 fluids or more at one time.
7. Can produce more heat transfer in ¼ the space, with ⅓ the weight.

What's your heat transfer problem? Liquid-to-liquid, gas-to-gas, liquid-to-gas? Condensing and vaporizing fluids? You may find a new and better solution in this new kind of all-aluminum heat transfer surface . . . developed by TRANE.

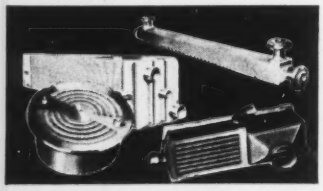
Write on your company letterhead for your FREE copy of "Extended Surface Heat Transfer Equipment."



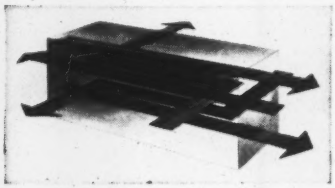
On large or small jobs, TRANE Brazed Aluminum Heat Exchangers can solve almost any heat transfer problem. Multiple-core units can be furnished. You can get temperature approaches of 5° to 10° F.



Select the surface you need. Straight and continuous, serrated, herringbone or perforated. Height, thickness and fin-spacing also can be varied to meet required heat transfer and pressure drop performance.



Design flexibility makes possible heat exchangers in many shapes . . . and in sizes up to 106" in length, with either bolt-on or integrally welded headers. For longer flow lengths, cores can be welded together in series.



Handle up to 5 fluids or gases, even more, at once. This symbolic drawing shows how. If your job requires one stream or many—high or low temperatures or pressures—solve it with TRANE Brazed Aluminum Heat Exchangers.

More heat exchange . . . closer temperature approaches

TRANE brazed aluminum heat transfer surface

The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn. • Trane Co. of Canada, Ltd., Toronto • 87 U.S. and 14 Canadian Offices

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

Whether you need

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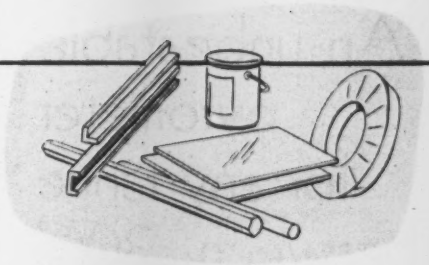
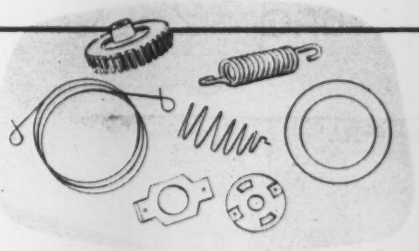
—Test Engineer



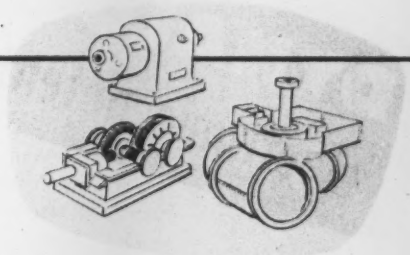
COMPONENTS

"I use the catalog to refer . . . for component parts for units produced by our firm."
—Mechanical Design Engineer



EQUIPMENT

"Offers a convenient source of reliable manufacturers who can be consulted for design and specific application of production equipment."
—Mechanical Engineer



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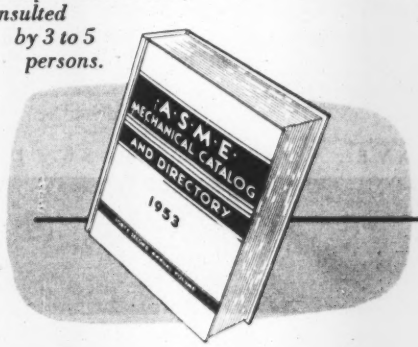
The ASME Mechanical Catalog, with its 385 pages of illustrated details, supplied by leading manufacturers, gives you the data you need to solve your specification problems. Whether you're looking for a spring insert, a steam boiler, or even a sheet of pure platinum, MC is always ready to give fast, complete answers. No wonder engineers agree . . . MC is "the best of references."

Consult your copy often.

**Records indicate that each of the 15,000 copies distributed, is consulted by 3 to 5 persons.*



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An unbeatable pyrometer for any range between -300° and +2800°F.

This simple variable capacitor is important to potentiometer users because it eliminates the conventional, troublesome slidewire altogether; and it gives Dynalog Instruments the continuous *stepless* balancing which assures higher accuracy, closer control.

*Reg. U.S. Pat. Off.

TOPS in simplicity . . . unequalled in its combination of accuracy, sensitivity, and speed of response . . . the Dynalog Potentiometer with standard thermocouples gives you unerring temperature measurement for any range up to 2800°F. Featuring *sustained* accuracy of ¼ of 1% of scale, it's an instrument of laboratory precision built to withstand the severest industrial conditions.

Unprecedented freedom from maintenance is the direct result of unique Dynalog design. There's no slidewire, no battery to standardize. There are no gears, belts, or high speed reversing motors. There's nothing to wear and cause dead space.

Single pen recording models provide full scale pen travel in 3 seconds standard, or as fast as 1 second without extra cost. The Multi-Record Dynalog provides color-coded records of up to 6 points at 6 second intervals. Both types give the convenience and low cost of circular charts.

Dynalog Potentiometers are also used for the measurement of pH, oxidation-reduction potential, and for other applications in which the process variable can be converted to a dc millivolt signal. They are available for pneumatic or electric control.

Write for your copy of Bulletin 427-1 which gives the whole story.

THE FOXBORO COMPANY, 965 NEPONSET AVE., FOXBORO, MASS., U.S.A.

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Single wrench maintenance

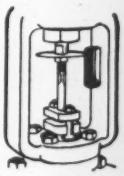
check these time and money-saving maintenance features

1

CAST FLATS make bolts easy to remove on superstructure. Heads can't turn . . . only one wrench needed.

2

WIDE YOKE—plenty of room for big hands to work with that one wrench.

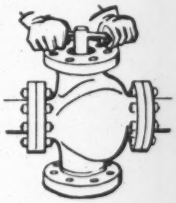


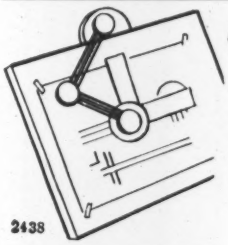
3

FLATS on valve stem use same adjustable wrench—does not score stem.

4

SEAT RINGS can be renewed without taking the valve body from the line. No vises, no lathes. Standard Leslie practice for 27 years, not a theory, a proven fact.





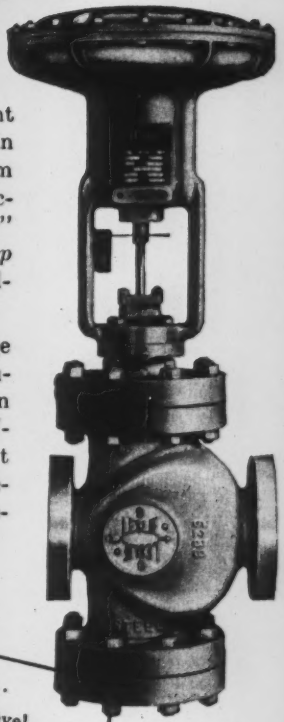
5

INTERCHANGEABLE parts keep inventory small, reduce down-time. Top grade materials and engineering means less maintenance.

2438

There are a host of important features found as *standard* in Leslie Double-Seated Diaphragm Control Valves usually manufactured only in "made-to-order" units — features that mean *top* performance and *extra*-dependable service.

But here's one more advantage that makes Leslie the most popular valve with maintenance men —SINGLE WRENCH MAINTENANCE. They find that maintaining the Leslie Double-Seated Control Valve is a one-tool job.



WHEN SPECIFYING . . .

for pressure, temperature and level controls, a quick check can prevent ordering a *special* that Leslie makes as *standard*. A call to your Leslie Engineer, before you specify, is free insurance. He's listed under "Valves" or "Regulators" in the classified telephone directories in principal cities.

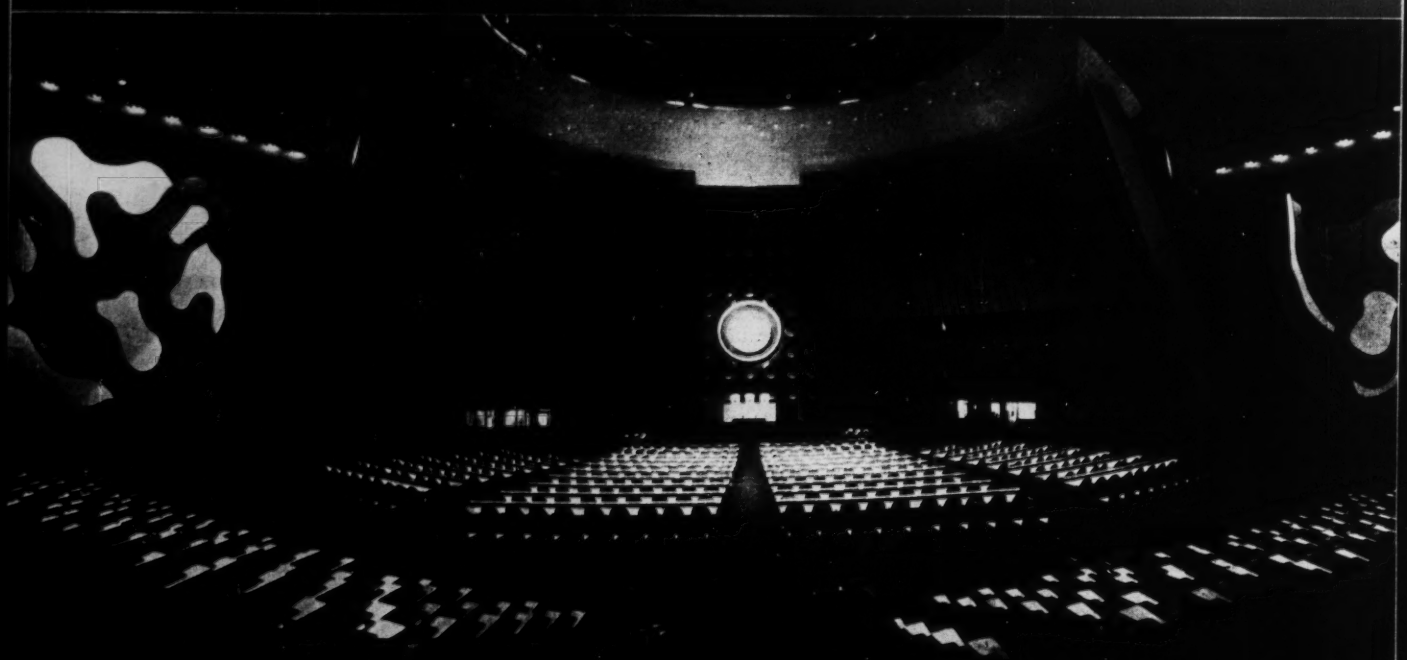
Send for free Bulletin 5305

12 new pages of valuable data on double-seated diaphragm control valves.

TRADE LESLIE MARK

LESLIE CO., 287 GRANT AVE., LYNDHURST, N. J.

UNITED NATIONS



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Seating Capacity: 2000 Delegates, Visitors, Press, Radio, TV and Translators

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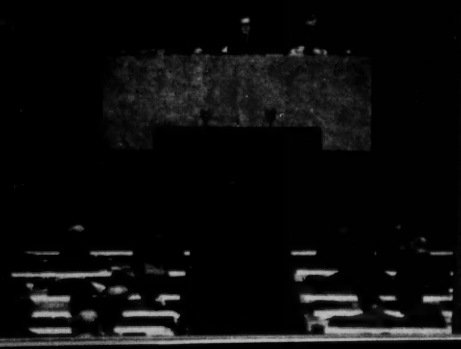
Contractor: KERBY SAUNDERS, INC.

Great Variety of Spaces Controlled by POWERS
In addition to the main hall and council chambers Powers control is used for the many tiers of glass booths occupied by the press, radio, TV and translators; also lounges, restaurants, bars, library, radio studios and garage. There is also considerable control for wall and panel heating and snow melting.



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TEMPERATURE AND HUMIDITY

THE POWERS REGULATOR CO.
Skokie, Ill. Offices in Over 50 Cities, see your phone book

(bf)

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Pneumatic Systems of
AIR CONDITIONING CONTROL

IN this famous international forum the engineers have succeeded in supplying optimum atmospheric environment for peaceful discussions which may help bring about a better world.

Many meeting and conference rooms and other spaces are individually controlled by Powers pneumatic thermostats. Dry bulb temperatures are set at the control panel with a Powers Series 100 Indicating Controller. Outside air is used for cooling during the intermediate season. Relative humidity is controlled during all seasons of the year. The seasonal changeover to summer, intermediate or winter is made with switches in the central control room.

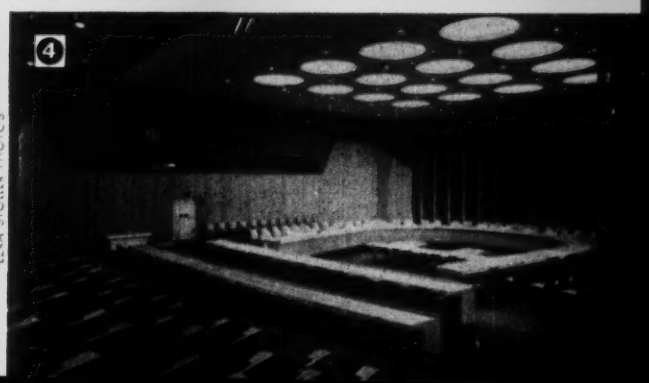
Experience gained by Powers here and in many other important large and small buildings may be helpful to you. Next time a temperature or humidity control problem arises, contact POWERS nearest office. There's no obligation.

Over 70 Powers Control Panels for as many complete air conditioning systems are used at UN. Gauges on each panel indicate the position of controls.

PHOTOS BELOW: (1) Translators in Air Conditioned Glass Booths (2) Security Council Chamber (3) Trusteeship Council Chamber (4) Economic and Social Council Chamber.

UNATIONS PHOTOS

EZRA STOLLER PHOTOS



(b6)

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A LITTLE FAME!

HERE'S your opportunity to get that for which you have lacked the wherewithal. There's just one catch — you will have to work for it! If you quit easily — don't read any further. Perhaps a little extra work on your thesis will do the trick.

An engraved certificate signed by the President and Secretary of the Society will accompany each award.

A trip to the Annual Meeting as a guest of the "Old Guard" will be awarded.

Students should consult the Honorary Chairman regarding the rules for these awards. Only papers by single authors will be considered.

Each student must submit his paper to the Vice President of the Region in which his Student Branch is located not later than June 1, 1953

$150.00

For the best paper by an undergraduate on a given subject. When it has been selected it will be sent to the Student Branches. This is the Charles T. Main Award.

An undergraduate must submit his paper for the Charles T. Main Award or Undergraduate Student Award before thirty days after the completion of his undergraduate work.

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For the best paper on an engineering subject by an undergraduate. This is the Undergraduate Student Award.

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29 West 39th St., New York 18, N. Y.

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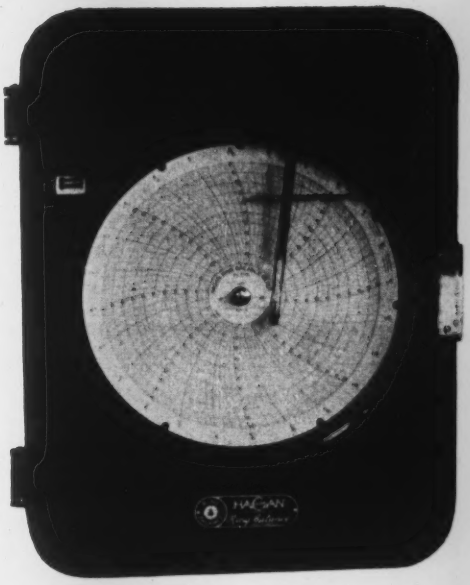

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Accuracy

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BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AUTOMOTIVE AND
AERONAUTICAL TESTING LABORATORIES

Hagan Ring Balance Flow Meters give dependable readings over the chart range, and give good response at low flow rates.

The calibration may be checked under full static pressure conditions by a simple check-weight method. One man can check calibration in a few minutes.

The simplicity of design, coupled with sturdy construction, assure long meter life and low maintenance costs.

The Hagan Ring Balance Meter is the most versatile meter made. Whatever your metering problems, our engineers will be glad to show you how Hagan Meters can help you solve them.

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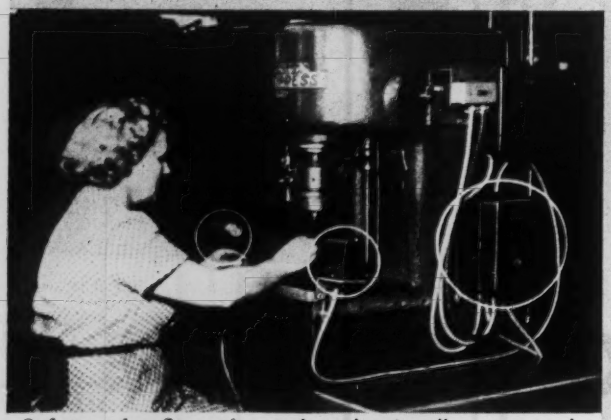
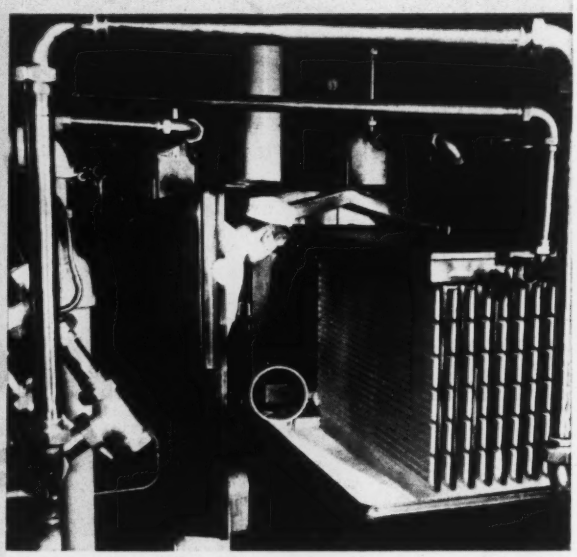
ME-5

"Electron-eering" with photoswitch controls

Your next step in control-efficiency



Safety at her fingertips — photoelectric cell protects worker's hand at this punch press. Press starts instantly when hand is withdrawn, increasing production, cutting costs.



Sanitary Level Control — easy-to-clean electronic liquid level control maintains precise level of fluid milk, regardless of foam, in cooler at modern dairy.

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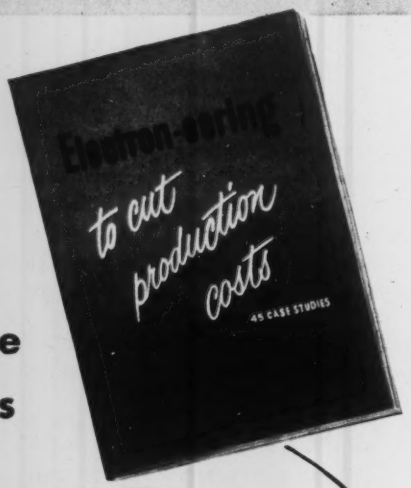
45 Case Studies



This book can save you money!

Right off the press! Crammed with new factual data and explanatory diagrams, this booklet tears aside all hocus-pocus and gives you a clear understanding of how electronic controls can solve your industrial problems. You'll find valuable tested ideas — broadly applied to industries — on achieving efficiency through "Electron-eered" counting, weighing, measuring, timing and cycling. Completely indexed. It can save you real money!

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Dept. MA 5, 77 Broadway, Cambridge 42, Mass.

Send free, "Electron-eering to cut production costs".

Name ..... Title .....

Company .....

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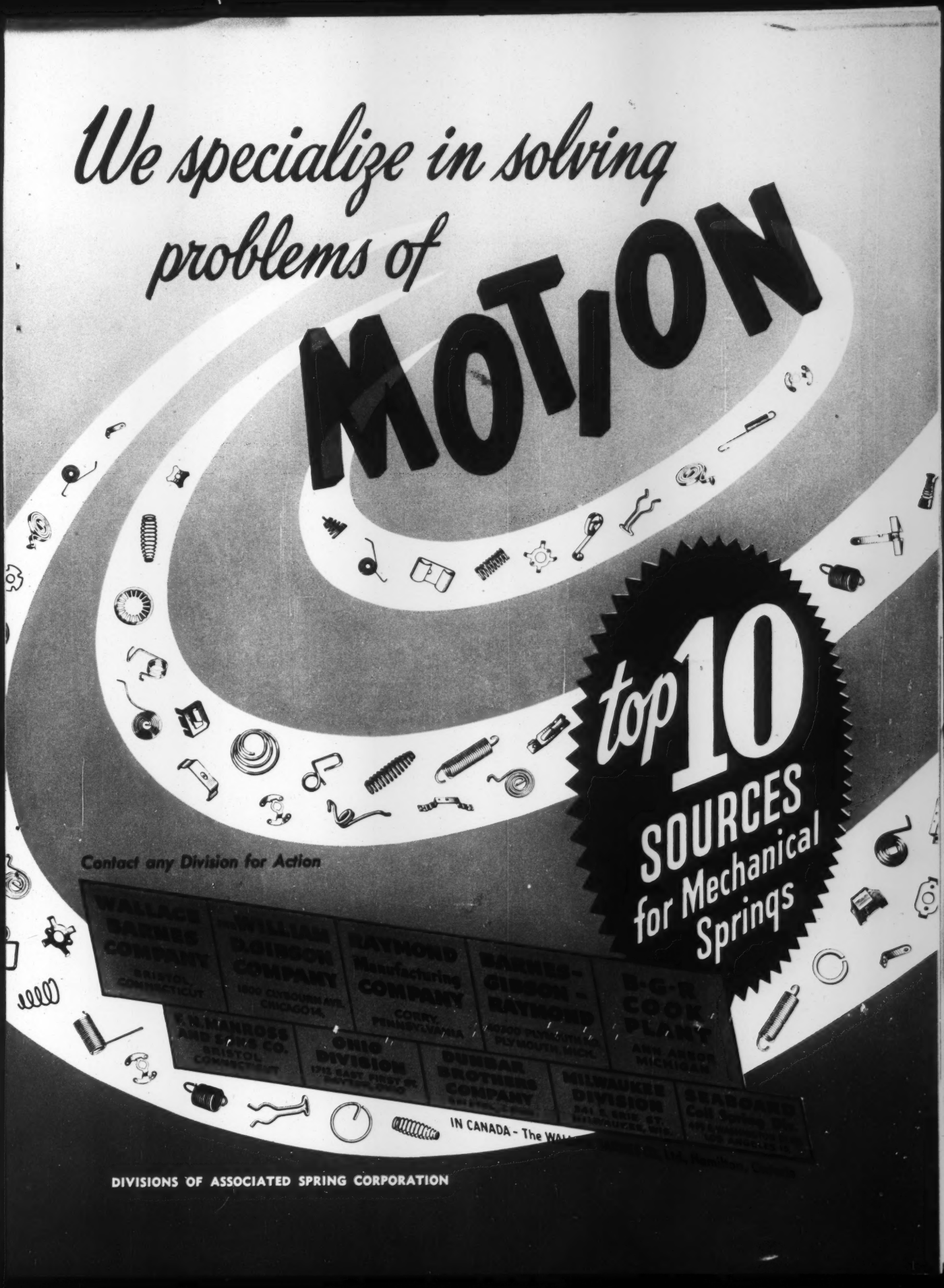
City ..... State .....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for Mechanical
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Contact any Division for Action
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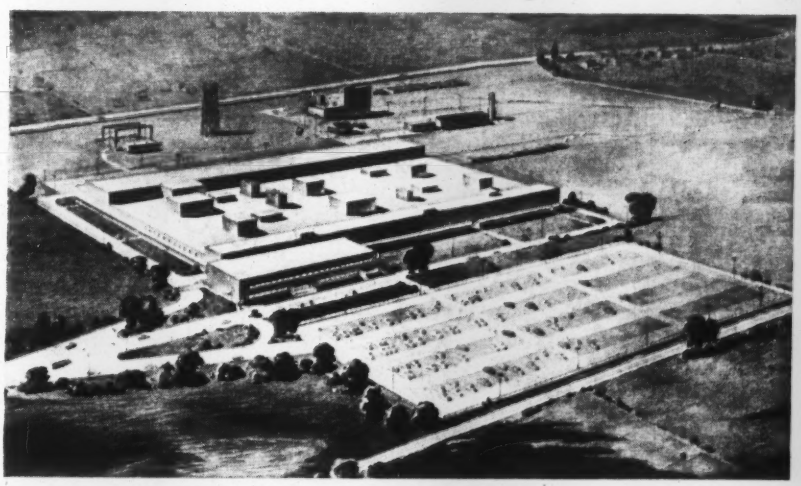
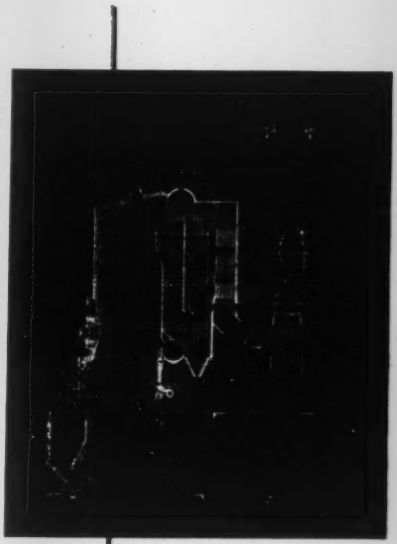
435 E. WASHINGTON BLVD. LOS ANGELES 15,
DIVISIONS OF
ASSOCIATED SPRING CORPORATION
IN CANADA - The WALLACE BARNES CO., Ltd., Ha

TWO WICKES STEAM GENERATORS will help heat the CATERPILLAR TRACTOR CO.'s new plant at York, Pa.



CONTRACTORS: Consolidated Engineering Company Inc., Baltimore, Md.
CONSULTING ENGINEERS: Whitman, Requardt & Associates, Baltimore, Md.



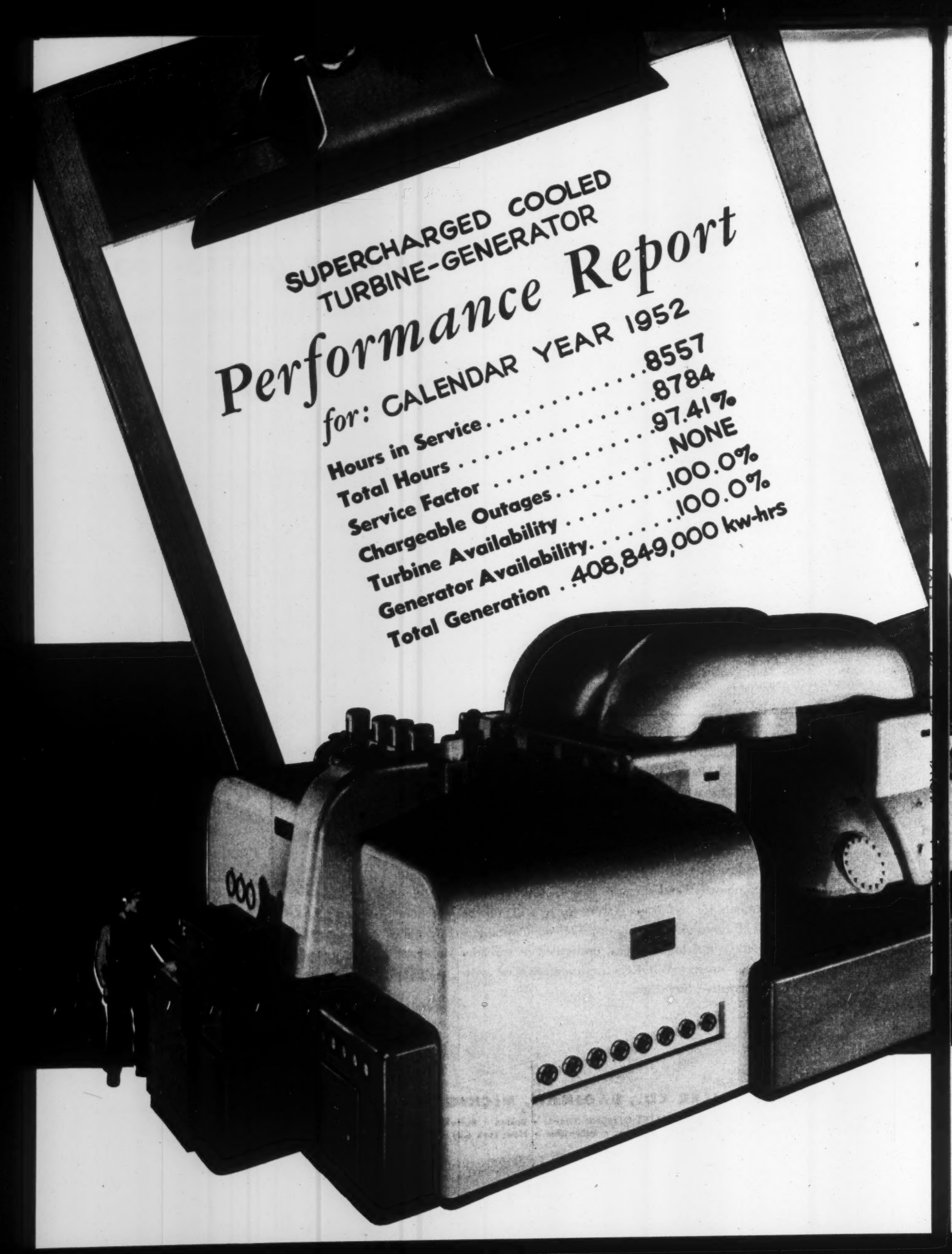
The Caterpillar Tractor Co., one of the world's largest manufacturers of earth moving equipment, will shortly open their new York, Pa. plant where several hundred men will turn out track assemblies for world famous Caterpillar D6, D7 and D8 Tractors. In this modern manufacturing facility, Caterpillar has installed two 80,000 lb. WICKES steam generators to obtain efficient, economical heat throughout the 360,000 sq. ft. structure. These Type R 2-drum WICKES boilers have a design pressure of 200 psi. and are equipped with economizers and spreader stokers. WICKES can fill your requirements for steam generators up to 250,000 lbs. per hour and 1000 psi. – all types of multiple drum boilers, adaptable to any standard method of firing: oil, gas, underfeed or spreader stoker. Consult your nearest WICKES representative or write us today for descriptive literature.

145

WICKES

THE WICKES BOILER CO., SAGINAW, MICHIGAN • DIVISION OF THE WICKES CORPORATION

RECOGNIZED QUALITY SINCE 1854 • SALES OFFICES: Atlanta • Boston • Buffalo • Chicago • Cincinnati • Cleveland • Denver • Greensboro, N.C. Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Pittsburgh • Portland, Ore. • Saginaw • Springfield, Ill. • Tampa Tulsa • Washington, D. C.


SUPERCHARGED COOLED
TURBINE-GENERATOR
Performance Report
for: CALENDAR YEAR 1952
Hours in Service 8557
Total Hours 8784
Service Factor 97.41%
Chargeable Outages . . . . . NONE
Turbine Availability 100.0%
Generator Availability 100.0%
Total Generation . . 408,849,000 kw-hrs

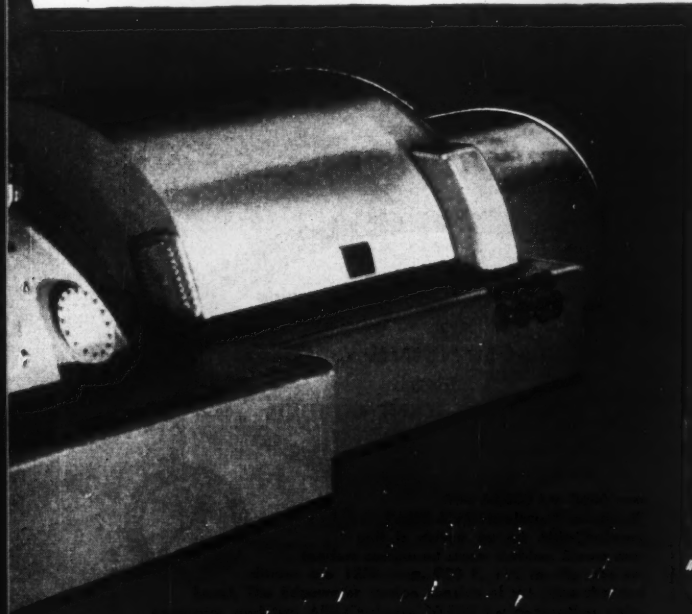
Availability for Duty: 100.0%!

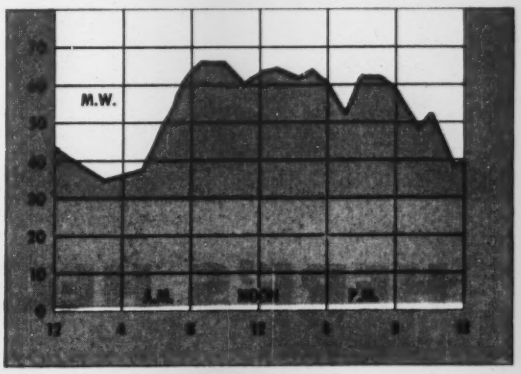
Supercharged Hydrogen Cooling — the greatest advance *ever* made in turbine generator design — has proved itself brilliantly in its first full year's commercial operation!

At left is the calendar year 1952 Performance Report on the Allis-Chalmers 60,000 kw steam turbine generator unit at the Edgewater station, Sheboygan, Wisconsin Power and Light Company. Both turbine and generator Availability were 100.0%, with on-the-line Service Factor over the entire year being 97.41%.

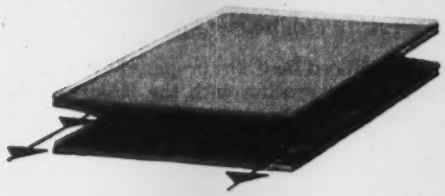
Cooling by driving hydrogen at high velocity directly *through* the conductors — supercharging — was first developed and applied by Allis-Chalmers. Supercharging has already permitted increase in generator rating of more than 70% over ordinary hydrogen cooling, with even greater gains forthcoming.

You get the real design advances *first* from Allis-Chalmers, builder of the world's widest range of power plant equipment. When planning a steam-electric power plant, your task will be simpler and results better if you deal with Allis-Chalmers. For complete literature on all products, call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3981





Typical daily load cycle of the Sheboygan supercharged unit. It experiences wide load fluctuations because it operates in parallel with base load hydro power. Supercharged units are suited for even this strenuous duty because of high part load efficiency and shorter, more thermally stable construction.

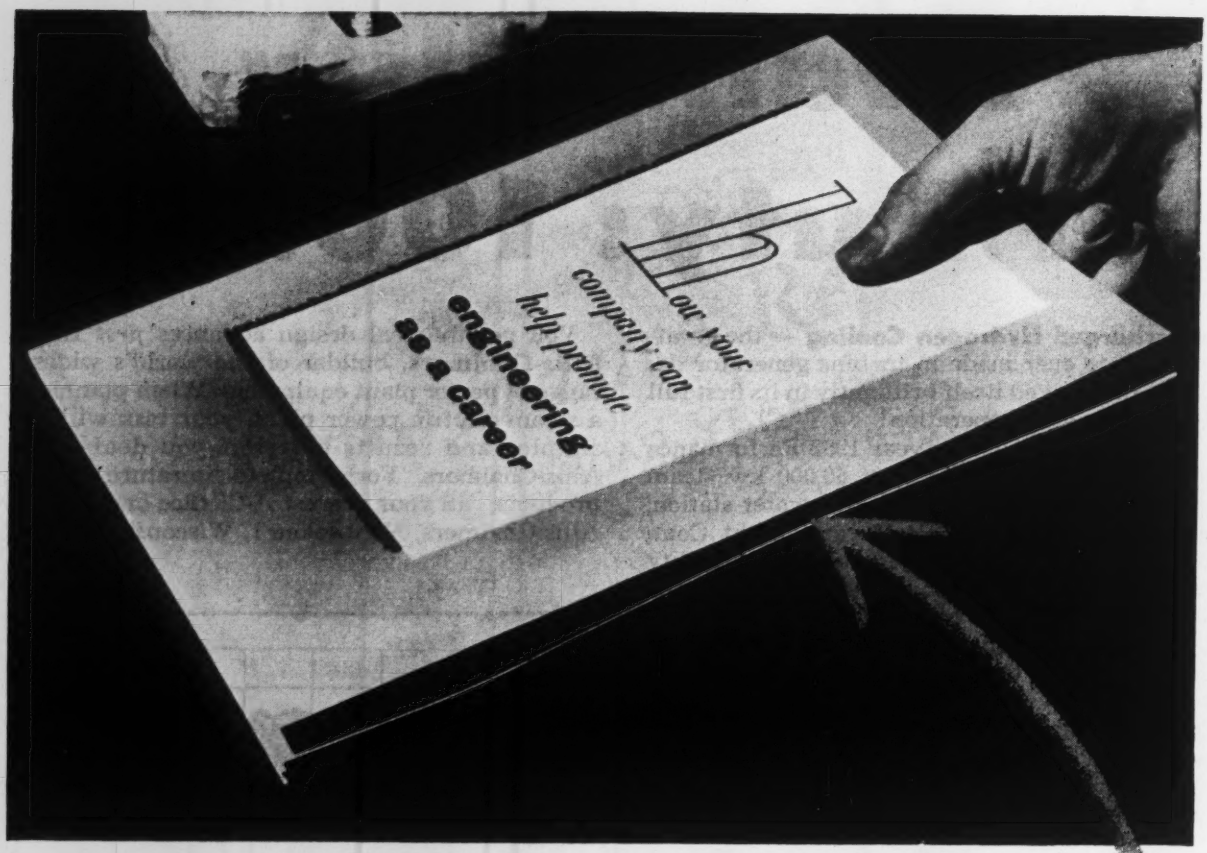


Cross sectional view, showing two turns of typical supercharged conductor construction. The cooling gas is in intimate contact with the copper, removing the heat right where it *originates*. The heat does *not* have to migrate through insulation and surrounding metal to reach vent ducts in the rotor teeth or body.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

FIRST **with Supercharged Hydrogen Cooling!**



HERE'S HELP

for your engineer-recruitment problem

Engineers' Joint Council and The Advertising Council offer free, expert help to advertisers promoting engineering as a career.

The booklet reproduced here was prepared by The Advertising Council in cooperation with the Engineers' Joint Council to help you make your advertising work most effectively in recruiting engineers for the future.

1. It tells you what the problem is and the important part you can play in solving it.
2. It outlines the advantages of an engineering career to help your company develop advertising appeals.
3. It informs you as to the current activities of industry in the education and recruitment of engineers.
4. It offers specific suggestions as to what you can do (from present manpower).
5. It provides material that you can use in your own local and national programs.

Many advertisers are using this booklet today. They say that it helps in orienting their engineer-recruitment advertising to industry-wide recruitment programs.

Send for this Free campaign guide
Prepared by
THE ADVERTISING COUNCIL
for the
ENGINEERS' JOINT COUNCIL

JUST MAIL THIS COUPON!

The Advertising Council, Inc.
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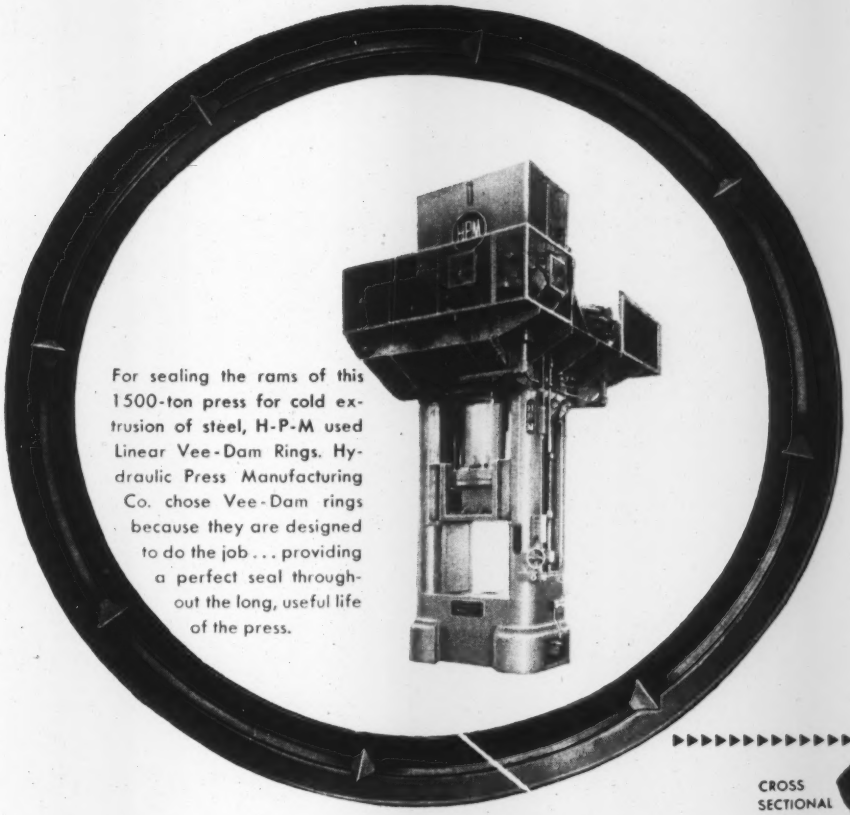
Gentlemen: Please send me a *free* copy of *"How your company can help promote engineering as a career."*

NAME: .....

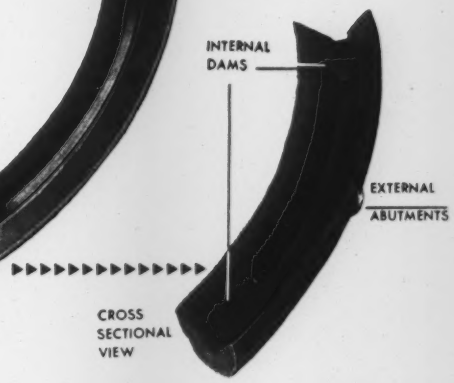
POSITION OR TITLE: .....

COMPANY: .....

ADDRESS: .....



For sealing the rams of this 1500-ton press for cold extrusion of steel, H-P-M used Linear Vee-Dam Rings. Hydraulic Press Manufacturing Co. chose Vee-Dam rings because they are designed to do the job . . . providing a perfect seal throughout the long, useful life of the press.



Now—a split V-ring packing that's really leakproof

LINEAR VEE-DAM RINGS

Usual split ring packings are always vulnerable to a common type of leakage. Unless the joint where the two ends of the ring meet is made perfectly tight originally . . . and stays that way in service . . . fluid leaks out between the rings.

LINEAR Vee-Dam rings, however, will not leak even when gaps occur at the ring joint through careless installation or variations in bore size.

The reason? Those sturdy rubber dams, faced in opposite directions, are moulded into the groove hinge area of the Vee-Dam ring. When rings are stacked together, these dams seal off sections around the circumference of the ring . . . form a hermetic barrier around any gap that might occur in the ring joint.

Further protection against leakage is provided by the smaller abutments on the outside shoulder edge which prevents lateral leakage.

LINEAR Vee-Dam rings are fabric reinforced elastomers, tailored for the job. Write or call LINEAR for full details.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA

DeZURIK EASY OPERATING PLUG VALVES

NO
LUBRICATION
FRICTION
STICKING
SCORING
LEAKAGE

DeZURIK VALVES bring a remarkably new and efficient valving principle to any service or process line — gaseous, liquid, viscous, fibrous. They operate with maximum ease, and with absolute minimum wear and care. A trial installation will prove their exclusive advantages. Full data on request.

DeZURIK
SHOWER COMPANY
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when better SYNCHROS are required SPECIFY *Telesyn*

FORD

- Proved Precision Accuracy
- Meet Government Specifications
- Corrosion Resistance
- Fungus Resistance
- Available in wide selection of sizes

WRITE FOR NEW TELESYN BROCHURE

Division of the Sperry Corporation
31-10 Thomson Avenue
Long Island City 1, N. Y.

NEW PRODUCTS ARE IMPORTANT

To swing the tide of prosperity it will be necessary for every industry to plan for the creation of new products.

Where gears are a part of any new product or their production machinery, Diefendorf is interested.

DIEFENDORF GEAR CORP.
Syracuse, New York

DIEFENDORF GEARS

MECHANICAL ENGINEERING
April, 1953 CARD INDEX Vol. 75, No. 4

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MECHANICAL ENGINEERING, 29 W. 39th St., New York 18, N. Y.

Additional information is requested on the following advertisements in the May 1953 issue

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Name Title

Company

Address

City State

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Go through the advertising pages and jot down the page numbers and names of advertisers about whose product you want additional information — mail the coupon to us — your request will be passed on to the advertiser promptly — you will hear directly from advertiser — saves your time in writing individual letters.

BRONZE CASTINGS
are only as good as the Foundry that makes them

—a truism so very obvious that it is frequently overlooked or forgotten . . . yet, because a Bronze Casting is often the foundation upon which a product is built, *Quality* just can't be taken for granted.

The numerous firms that have depended upon "A.M.B." for their Bronze Casting requirements, *know* that "A.M.B." offers the experience and "know-how" gained over 42 years.

Send for 48 page Reference Book of "Bronze Casting Alloys" and be convinced. And please use your business letterhead when requesting it.

AMERICAN MANGANESE BRONZE COMPANY

4703 RHAWN ST., HOLMESBURG, PHILADELPHIA 36, PA.

Established 1909

the **GEROTOR** mechanism

because it's
PRECISION
engineered

In every GEROTOR pump or motor, precisely paired gear-shaped elements transmit power from or to the shaft with high efficiency. These elements, revolving in the same direction at low relative speed, constitute the GEROTOR mechanism . . . famed for longer life, less wear, less slippage, dependably smoother performance. With GEROTOR pumps or motors, hydraulic circuits "run like clockwork", too.

Gerotor May Corp. . . . Baltimore 3, Md.

GEROTOR
HYDRAULIC PUMPS & FLUID MOTORS

Engineers

AN INVITATION TO YOU TO GO PLACES WITH FAIRCHILD

Earl E. Morton, Chief of Aerodynamics. Has had many years of experience in aircraft manufacturing and was responsible for engineering on many now famous aircraft.

A secure future, exceptional opportunities for advancement, and a high starting salary await you at FAIRCHILD. We have openings right now for qualified engineers and designers in all phases of aircraft manufacturing.

Paid vacations, liberal health and life insurance coverage, 5-day, 40-hour week as a base. Premium is paid when longer work week is scheduled.

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD *Aircraft Division*
HAGERSTOWN, MARYLAND

6 "built-in" design features...

give you improved performance

with LOVEJOY UNIVERSAL JOINTS

Smooth, sensitive operation and optimum, long-lasting performance are yours for complete service satisfaction with LOVEJOY Universal Joints.

Precision-built of high quality, heat-treated alloy steel and ground to infinite accuracy, they fully meet your most rigid job requirements.

The painstaking design incorporated in LOVEJOY Universal Joints is evident in these features:

1. Concentricity guaranteed to .001"
2. Rivets ground flush with body for close-quarter work.
3. Greater angle of operation.
4. Maximum strength, minimum weight.
5. No binding, backlash or inplay of pins.
6. Exceed rigid requirement of Armed Forces.

Available in 13 sizes. Hub diameters 1/2 to 4 in. Bore diameters 1/4 to 2 in. Lengths 2 to 10-5/8 in.

Write now for Catalog

LOVEJOY FLEXIBLE COUPLING CO.

5032 W. Lake St. Chicago 44, Ill.

Also Mfrs. of Lovejoy Flexible Couplings and Lovejoy Variable Speed Pulleys

NEW MARSH Serviceman Soundscope

. . . cuts servicing and maintenance costs

Most effective instrument ever developed for pin-pointing and identifying mechanical defects. Saves time and dollars tracking down troubles in bearings, gears, mechanisms . . . detects leaks, knocks, piston slaps—any defects that make a sound. A precision instrument of Marsh quality, sensitive to faintest sounds . . . with handy probe and headband as illustrated. A remarkable tool, moderately priced.

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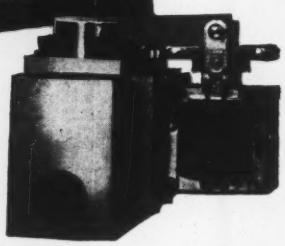
MARSH INSTRUMENT CO.

Sales affiliate of Jas. P. Marsh Corporation

Dept. 29, Skokie, Illinois

High Pressure SOLENOID VALVES . . .



have working pressures range as high as 3000 psi. Specifically designed for remote push button control of hydraulic systems, as well as for the handling of any non-corrosive fluids. Poppet construction eliminates leakage. Impregnated coils are oil and moisture resistant. Unit can be mounted in any position. Available in 110-220 A.C.

Write For Illustrated Circular G.

WATERMAN ENGINEERING Company

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The All-Electric Adjustable-Speed Drive

designed to supersede mechanical gear boxes, clutches and variable-pitch cone pulleys

RELIANCE V★S DRIVE ®

JR.

3/4 to 3 HP.

STYLE E

Get the Facts!

Ask for Bulletin D-2102. It describes and illustrates features, applications, components and operation; dimensions and characteristics are also included.

SAVES YOU MONEY 10 WAYS!

- Boosts output
- Cuts down rejects
- Saves space
- Increases safety
- Handles more jobs
- Reduces "down time"
- Simplifies machine design
- Reduces operator fatigue
- Cuts changeover time
- Operates from a-c.

D-1481

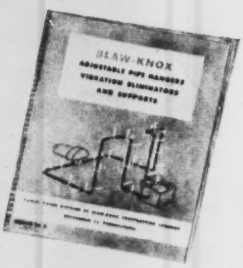
RELIANCE ELECTRIC AND ENGINEERING CO.

1062 Ivanhoe Road, Cleveland 10, Ohio • Sales Representatives in Principal Cities

All Movements Under Control with a

BLAW-KNOX OVERHEAD ROLLER ASSEMBLY

Type 9 Functional Assembly (illustrated) provides free rolling action in two directions and freedom of movement in vertical position. Its *internal swivel* action gives full control over all movements, and minimizes absorption of piping thrusts by the connecting flanges . . . a big help in keeping maintenance and replacement costs at rock bottom. Available for all standard size piping. Accommodates operating loads up to 12,000 lbs.



Catalog No. 53 on request.

BLAW-KNOX COMPANY
POWER PIPING AND SPRINKLER DIVISION
PITTSBURGH 33, PA.

BLAW-KNOX

Imperial

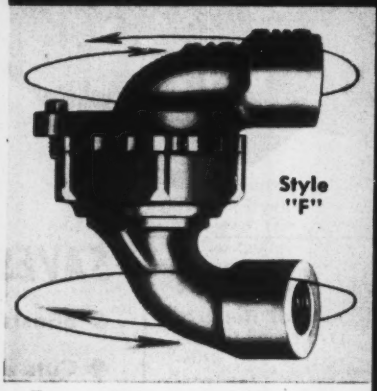
THE *Finest* TRACING CLOTH

Imperial is known in drafting rooms all over the world as the traditional quality tracing cloth.

With the background of decades of experience, its makers have pioneered in modern improvements to maintain Imperial as the finest tracing cloth made.

FLEXO JOINTS

for pipe lines that *move!*



For unrestricted flow of steam, air, or fluids through moving pipe lines or to equipment in motion.

Complete 360° swing. The strength of pipe with the flexibility of hose. Only four parts assure long wear, low maintenance. No springs, small or loose parts. Four styles in standard pipe size, ¼" to 3".

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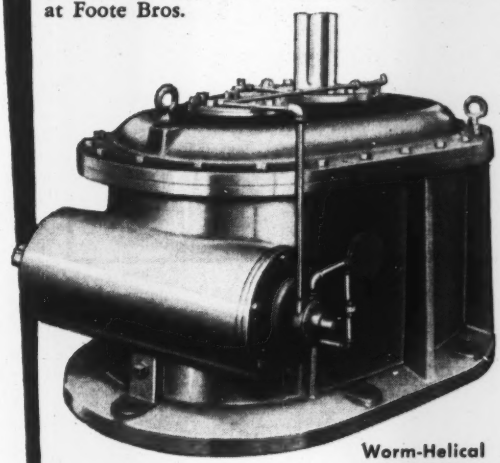

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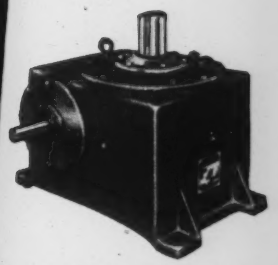

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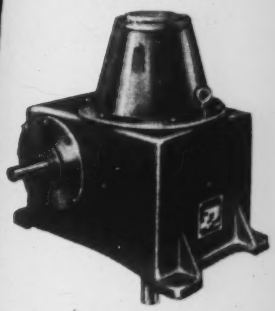

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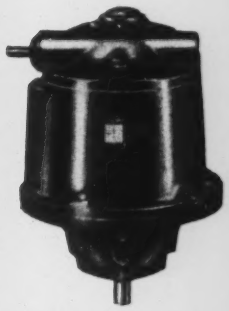

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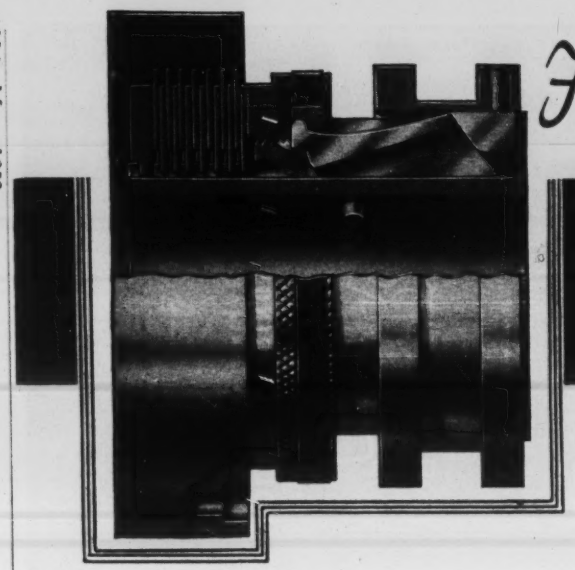

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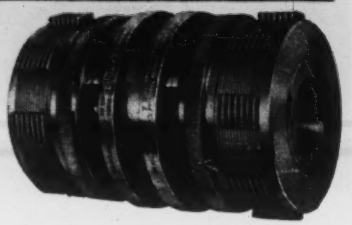

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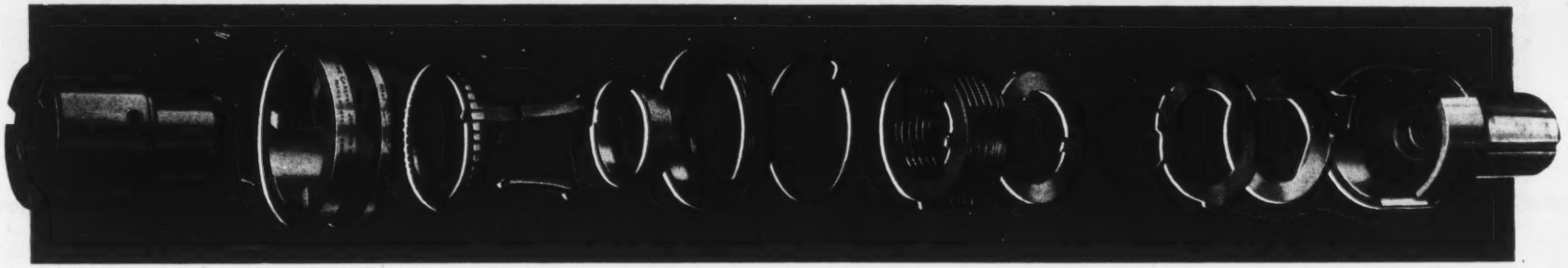

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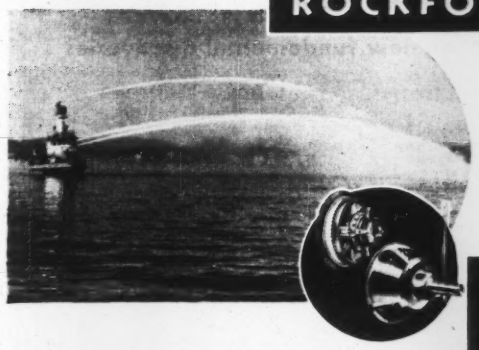

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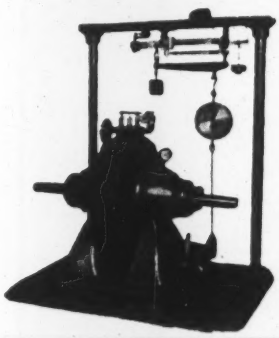

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EQUIPMENT DESIGN
EQUIPMENT MAINTENANCE

We also have an opening for an engineer with experience in press-forming of large glass items to organize and supervise a small engineering section. Work is of a process control and development nature reporting to the Engineering Superintendent of the main plant of this expanding division of a major glass manufacturing company.

There are excellent possibilities for advancement in our engineering and manufacturing operations for engineers with initiative and ability. All travel-, living-, and moving expenses for yourself and family during relocation in central Ohio will be paid for by our company.

Your reply will be treated confidentially and should cover experience, education, salary requirements and general personal statistics.

Our engineers and engineering supervisors know of this advertisement.

Address CA-4311, care of "Mechanical Engineering."

geared to new ideas in electromechanics...

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One of the big reasons for the success of North American Aviation's Electromechanical Department is its painstaking attention to small details—like the millionth of an inch on a gear or the hairline accuracy of the tiny part shown on the contour projector. These small details are some of the factors contributing to the complex missile guidance and automatic control systems which are being designed and developed by this department for projects which stagger the imagination.

North American's fine reputation for pioneering in far-reaching technical fields is part of the answer to the question: "Why do so many talented engineers choose North American as a place to work?" Another is the extremely advanced equipment – much of it invented and built by North American itself – available to the engineers who work here.

In addition to North American's popularity as a place to work, there are always fine career openings for imaginative scientific minds. If you like theory, you will discover an exciting and secure future in the fields of operations analysis, advanced dynamics, kinematics, noise, error or information theory, systems engineering, statistical quality control or servo analysis.

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Why not write for complete information, giving us your education and experience?

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Engineering Personnel Section, Missile and Control Equipment Operations

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NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

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AIRCRAFT ARMAMENT

The Chicago Midway Laboratories is developing airborne armament and weapons systems for the USAF. The engineering staff requirements of this expanding activity include:

A CHIEF ENGINEER to assume the responsibility for, and guide the activities of, a large and diversified mechanical engineering program. This will involve working in close contact with parallel groups in electronics and physics.

SENIOR ENGINEERS to supervise the individual projects.

EXPERIENCED MECHANICAL ENGINEERS and RECENT GRADUATES to complete the staff.

Experience in aeronautics or ordnance is desirable although not essential; the chief requirement is for mechanical engineering and design.

The project is located on the campus in a completely modern laboratory and shop facility. Salaries are comparable to those of industry and there are additional benefits such as liberal vacations, congenial and competent colleagues, and the close association with an outstanding academic institution. U. S. citizenship required.

Scientific Personnel Office
Chicago Midway Laboratories
6040 South Greenwood Avenue
Chicago 37, Illinois

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We need Mechanical Engineers to work on design of small mechanisms, light structures, gear trains, chassis and packaging units as applied to electronics communications equipment.

Men we want must have M. E. or A. E. degree, with one or more years experience in mechanical design.

Positions involve board design, model shop association and construction-testing of primary models.

You benefit from excellent starting salary, ideal working conditions in modern plant, paid vacations and holidays and good chance for rapid advancement. Housing immediately available in beautiful suburban and country areas that surround the Bendix plant.

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If not listed, write to us upon your Company letterhead, informing us under what product classifications your firm should be listed.

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With 5 to 10 years' experience in general machine design. Design of special test equipment preferred but not mandatory. Unusual opportunity to make fast progress and gain quick recognition in an uncrowded industry; diversified work on a wide variety of projects. Company-furnished meals, insurance, hospitalization and medical care. Liberal vacation policy. Plant location Cleveland suburb close to good residential areas. Outline experience and minimum salary requirements in letter. Write Engineering Department No. 3261-27.

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Two years' or more experience in the field of thermodynamics and heat transfer. Prefer men with MS degree but not mandatory. Permanent, good paying. Company-furnished meals, insurance, hospitalization and medical care. Liberal vacation policy. Air-conditioned quarters. Plant location close to good residential area.

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Mechanical Engineers, Electronics and Electrical Engineers, Physicists, Aerodynamicists, and Mathematicians. A variety of positions in research and development open for men with Bachelors or advanced degrees with or without applicable experience.

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For old, established Forge and Fabricating Shop. The man for this position should have the following qualifications:

Age 30 – 40
College Graduate
5 years' experience
Ability to Contact Customers
Metallurgy Experience

If you can fill these qualifications, please write outlining your experience and background.

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MECHANICAL ENGINEER

Responsible permanent position in new section of established company.

Graduate, age 35–50, experienced in chemical industry design including pressure vessels, piping, materials and specifications.

Paid holidays . paid vacation . low cost group health, accident, and life insurance . retirement plan. .

Salary commensurate with ability and experience.

Submit resumé of personal history . education . experience . salary expected.

Application confidential.

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to fill responsible permanent position in group working on design, construction and experimental operation of equipment for production and processing of plastics. Several years' experience in development of mechanical equipment is essential and a degree in mechanical engineering desirable. Full details of experience, training, educational background and salary requirements should be included in your letter which will be treated in confidence. Suburban housing readily available nearby.

ROHM & HAAS CO.
Plastics Laboratories
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Positions now available for highest caliber personnel in the field of airborne automatic electro-mechanical control equipment.

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Write or Apply

AC Spark Plug Division
General Motors Corporation
1925 E. Kenilworth Place
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Additional Opportunities are offered in the display advertisements— on pages 58, 70, 75, 117.

TO ELECTRO-MECHANICAL ENGINEERS AND DESIGNERS

with experience in

SMALL, PRECISION DEVICES

HUGHES RESEARCH AND DEVELOPMENT LABORATORIES, one of the nation's leading electronics organizations, is now creating a number of new openings for qualified electro-mechanical engineers and designers in important phases of its operations.

HOW TO APPLY

Write today to address below, giving details of qualifications and experience. Assurance is required that any relocation of an applicant will not cause disruption of an urgent military project.

THE COMPANY

The Hughes Laboratories, located in Southern California, are presently engaged in the development and production of advanced radar devices, electronic computers and guided missiles.

THE OPPORTUNITIES

Opportunities are offered for men who will perform interesting work on development of intricate new devices in close association with outstanding scientists. Activities will embrace a variety of challenging problems requiring originality and affording unusual possibilities of progress in learning.

FIELDS OF WORK

The work includes such fields as those involving Servo Mechanisms, Computers, Microwave Tubes, Pulse Circuitry, Solid-State Physics, Miniaturization, Antennas—Waveguides, Heat Transfer, Hydraulics—Gyros, Test Equipment, Subminiaturization, Stress Analysis, Instrumentation, Structures, and Precision Production Mechanisms.

YOUR FUTURE

Working experience in advanced techniques employing the above fields will increase your value to the Company as it further expands in development of electro-mechanical devices. Large-scale use of electronically controlled systems in business and industry is a certainty within the next few years.

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES
SCIENTIFIC AND ENGINEERING STAFF
CULVER CITY, LOS ANGELES COUNTY, CALIFORNIA

MECHANICAL ENGINEER
PRODUCT DEVELOPMENT

To assist in product development and laboratory testing. Will be expected to lead a small group whose sole duties will be the development of new products of a mechanical nature. Applicants should be mechanical engineering graduates, with primary experience in the iron and steel manufacturing industry. Two to four years' apprenticeship in shop work and drafting required. Should have general knowledge of mechanical design and mechanical laboratory practice. Experience in a major capacity in product development projects essential.

The company manufactures essential equipment for public utilities, industries, transportation and government agencies. Basic operations include manual arc and flash welding, hydraulic and crank press work, forging and machining. Long range expansion program will provide additional manufacturing facilities for present products and those in the development stage. Applicants should submit complete resumés, including salary requirements. All replies will be held confidential.

Address CA-4313, care of "Mechanical Engineering."

CHIEF ENGINEER

Progressive Canadian concern seeks graduate mechanical engineer with at least five years' experience in the design of pressure vessels, heat exchangers and bubble trays. Should have a good general knowledge of the equipment for the petroleum and petro-chemical industry.

In applying, furnish a detailed resumé of your education, experience, reference and a recent snapshot. Salary open.

Address CA-4335, c/o "Mechanical Engineering"

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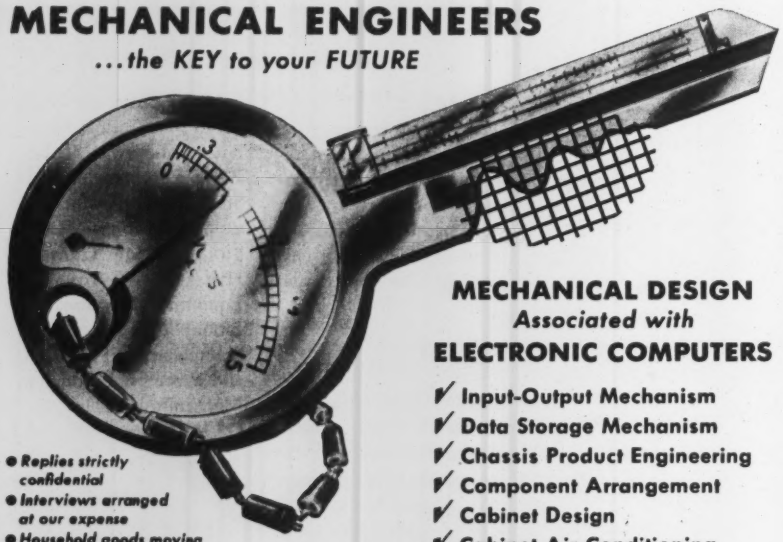

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Our continuing expansion program offers outstanding opportunities to men with extensive education and experience in the above fields.

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Experienced Engineers required in Engineering Department for expansion program covering Steam Power Plants, Electric Generation, Transmission and Substations and Gas Production and Transmission. Jobs offer permanent employment with ample advancement opportunities for men with ability and initiative.

Pleasant congenial suburban community in close proximity to a Metropolitan Area.

Write giving full particulars of education, experience, and salary to:

BOX CA-4300

When required personal interviews will be arranged for evenings or Saturdays.

It will pay you to watch the announcements on these pages
for an opportunity that you have been looking for
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a better life...
in California

There's more to a job at Lockheed than eight hours' work a day. There's the friendly spirit of progress—of getting things done—that makes work so much more stimulating. There's the better life you live—just because you live in Southern California. There's the future that offers you and your family security and advancement with the *leader in aviation.*

New design ideas spring from spontaneous conferences such as these

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On the job, you work in an atmosphere of vigorous, progressive thinking. Personal initiative, new ideas are encouraged. Frequent conferences iron out problems, keep work rolling smoothly. You work with top men in your profession—as a member of the team known for leadership.

Outdoor life prevails in Southern California the year around

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Every day, you get a "bonus" at Lockheed—in the better living conditions. The climate is beyond compare. Recreational opportunities are unlimited. Golf, fishing, the patio life at home can be yours 12 months a year. And your high Lockheed salary enables you to take full advantage of the climate and recreational opportunities.

Special training courses prepare you for promotion

Better Future

You have a *future* at Lockheed—not just a job. For Lockheed is building planes for defense, planes for the world's airlines. The planes of tomorrow are being designed today in Lockheed's long-range development program.

Special training courses in management and various phases of aeronautical engineering help prepare you for the future and promotion. Ask any of the 5,000 who wear 10-year pins whether or not there's a career and security at Lockheed.

To Engineers with Families:

Housing conditions are excellent in the Los Angeles area. Thousands of rental units are available. Huge tracts for home ownership are under construction now. Thousands of homes have been built since the last war. Lockheed counselors help you get settled. Educational facilities also are excellent. The school system offers your children as fine an education as can be obtained anywhere. Elementary and high schools are conveniently located. Junior colleges and major universities abound—21 are in the Los Angeles area.

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- Airplane Specifications Engineers
- Ballistics Engineers
- Design Engineers "A" & "B"
- Engineering Drawings Checkers
- Flight Test Engineers "B"
- Flutter and Vibration Engineers
- Instrumentation Engineers
- Jr. Engineers—Draftsmen "A"
- Jr. Engineers—Draftsmen "B"
- Numerical Mathematical Analysts
- Research Engineers
- Scientists for systems analysis and military operations research
- Service Engineers
- Servomechanism Engineers
- Stress Engineers
- Structures Engineers
- Weight Engineers

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Mr. M. V. Mattson, Employment Manager, Dept. ME-5

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Aircraft experience is *not* necessary for a job at Lockheed. It's your general engineering background—your aptitude—that counts. Lockheed will train you to be an aircraft engineer—*at full pay.*

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"OPPORTUNITIES" Section This Month 127-136

CHEMICAL ENGINEER OR MECHANICAL ENGINEER

Graduate, preferably with power plant or water treating experience, for sales and service work in Ohio and other states. Outstanding opportunity due to expansion with established national concern. Salary, expenses and bonus.

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NEW job opportunities with . . . a NEW Bendix Division! NEW Electronic Products!

This new division of the Bendix Aviation Corporation in York, Pennsylvania has a bright future, and this is your opportunity to get in on the ground floor with excellent possibilities for advancement.

Our work in producing new electronic products involves the need for Mechanical Engineers at several levels of technical accomplishment.

. . . And at the Bendix York Division you benefit from high wages, paid vacations and holidays and ideal living conditions in a beautiful suburban area.

Send resumé of Education and Experience to Mr. L. D. Smith, Employment Supervisor

Bendix

AVIATION CORPORATION YORK DIVISION

Phone: York 5521 **York, Penna.**

MECHANICAL ENGINEER

Major petroleum refiner is seeking general foreman for its engineering laboratory in metropolitan Chicago. Qualifications: practical machine shop experience; background in heavy electrical equipment; proved supervisory ability. Business training an asset. Salary $8,000 to $10,000. Please submit resumé of education and experience with reply. Replies held confidential.

Address CA-4325, % "Mechanical Engineering."

WATCH ENGINEER

for 600,000 lb./hr. boiler plant of a large factory in Western Maryland. Applicant must be under 40 years of age and experienced in the operation of large pulverized coal and underfeed stokered boilers. Rotating shift work. Applicant must have a high school education. Salary open. Pension and insurance benefits.

Address CA-4322, % "Mechanical Engineering."

MECHANICAL ENGINEER

We need one experienced BS or MS Mechanical Engineer for design, construction and maintenance work in connection with bench scale and pilot plant research in coal processing. This position offers an exceptional opportunity for advancement both in research and in anticipated commercial fields. Replies including education, experience, references, salary desired and recent photograph should be directed to:

Pittsburgh Consolidation Coal Company
Research and Development Division
Library, Pennsylvania
Attention: William F. Saalbach
Advisor on Personnel

MECHANICAL DESIGN ENGINEER—with experience in Industrial Chemical or Steam-Electric Power Plants. Must be qualified for design, specifications, cost estimates, supervision and client contacts. This position is with a growing organization of Design Engineers located in Philadelphia and offers an opportunity for advancement and permanency. Write giving complete personal history, experience and earnings record, and references. Address CA-4309, care of "Mechanical Engineering."

DESIGN ENGINEER—with experience in Plumbing, Heating, Ventilating and Air Conditioning for work on Industrial, Chemical and Power Plants. Must be qualified for design, specifications, cost estimates, supervision and client contacts. This position is with a growing organization of Design Engineers located in Philadelphia and offers an opportunity for advancement and permanency. Write giving complete personal history, experience and earnings record, and references. Address CA-4310, care of "Mechanical Engineering."

MECHANICAL ENGINEER—To assume administrative responsibilities for company in New York City area. Must have M.M.E. degree. Age: 35-40. Salary: $10,000. Please send detailed resumé. Address CA-4316, care of "Mechanical Engineering."

TEACHING POSITION—Engineering graduate, Industrial and teaching experience desirable. Opportunity to work on advanced degree. Salary depends upon qualifications. Write: Head, Department of Engineering Drawing, Iowa State College, Ames, Iowa.

DESIGN AND DEVELOPMENT ENGINEER—Established Midwest Manufacturer desires experienced engineer for expanding department to design fuel, hydraulic, and pneumatic valves for aircraft. Please give complete resumé of practical experience, detailed information on education, salary desired, and other pertinent data. Address CA-4332, care of "Mechanical Engineering."

A SALESMAN for a nationally known Pipe Fabricating and Erecting Company. College graduate in Engineering, plus knowledge of the piping industry required. Person desired: Approximately 35 years of age and willing to do extensive traveling. Good salary and expenses. Address CA-4298, care of "Mechanical Engineering."

MECHANICAL ENGINEER—Opportunity for experienced mechanical engineer to join long established company in midwest. Products sold throughout the world. Excellent employee benefits. Must be capable of supervising design and developments of major equipment used in mining, crushing and cement industry operations. Replies treated confidentially. Give experience, age, references and salary requirements. Address CA-4222, care of "Mechanical Engineering."

GRADUATE MECHANICAL ENGINEERS and PHYSICISTS—who want to develop their experience by working on varied mechanical research and development contracts, either design or test including kinematics, mechanics, measurement of high-speed transient forces and motion, some military work (U. S. Citizens only). For application and particulars of positions available write: Engineering Mechanics Department, Southwest Research Institute, Post Office Box 2296, San Antonio, Texas.

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—

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MECHANICAL ENGINEER—B.S. Age 37, married, 15 years' diversified experience in ferrous foundry and machine shop, producing medium and heavy equipment. Responsible positions in production planning, supervision, and maintenance. Desires position as administrative assistant in medium size manufacturing organization preferably in the southeast. Address CA-4308, care of "Mechanical Engineering."

MECHANICAL ENGINEER—B.S.—38—varied experience in development and production of medium and large machinery. Administrative experience. Thorough knowledge of drafting room practice and techniques. Proved ability to organize and supervise. Desires responsible supervisory position. Address CA-4318, care of "Mechanical Engineering."

MECHANICAL ENGINEER—BSME, Single, Age 30, desires employment in South America. Experience in aviation and automotive mechanics, geodesy, lumbering, road construction, and residential contracting. Speak, read, and write both Spanish and Portugese. A year and a half spent in Brazil, Bolivia, and Panama. Address CA-4319, care of "Mechanical Engineering."

MECHANICAL ENGINEER—32, married, BS in ME, MS in Applied Mechanics, completing Doctorate in ME, seven years' diversified experience. Excellent shop practice. Inventive, energetic, versatile. At present supervising product development and design from idea conception to final production. Seeks top-level position. Present salary, $8,000. Address CA-4320, care of "Mechanical Engineering."

MECHANICAL ENGINEER—age 28, M.S.; expects PhD next year. 2 years' industrial testing and research, 0 years' university teaching and research. Strong analytical background in stress, heat transfer, gas dynamics, servomechanisms. Desires research, consulting, or advanced development position in East. Address CA-4321, care of "Mechanical Engineering."

MECHANICAL ENGINEER 1941—Machine Designer, some administration, utility, instruments, marine, heavy machinery, conveyors, structural, aviation and shop experience. Can start as checker. Locally. Address CA-4324, care of "Mechanical Engineering."

GRADUATE MECHANICAL ENGINEER—24, BSME, married. Majored in tool design. Prefer work in production or development field. Currently completing tour of military service. Korean veteran. Present income $5,000 per year. Address CA-4326, care of "Mechanical Engineering."

"OPPORTUNITIES" Section This Month 127-136

POSITIONS WANTED

Continued from Page 135

ASSOCIATE PROFESSOR of MECHANICAL ENGINEERING—Ph.D., with diversified background, desires change. Address CA-4327, care of "Mechanical Engineering."

ENGINEERING INSTRUCTOR, MME, working on doctorate 5 years' experience, heat power engineering. Available for industrial employment June-Sept. Prefer N. Y., N. J., Conn. area. Address CA-4329, care of "Mechanical Engineering."

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MANUFACTURERS AGENT—Wants lines of reputable equipment. Will give your product the representation it needs. Operating out of Jacksonville and covering any or all of Florida, Georgia, and Alabama. Engineer, experienced in design, estimating, and contracting of Air Conditioning, Heating, Ventilating, Process Piping and Plumbing. Has directed large sales force and has had own Mechanical Contracting Company. Address CA-4317, care of "Mechanical Engineering."

See Advertisements on Preceding Pages

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EXECUTIVES, ENGINEERS, DESIGNERS, SPECIALISTS. Our staff—technical graduates—serving both employer and applicant 20 years'—no fee until placed—Bradley Placement Service, 555 Leader Building—Cleveland 14, Ohio.

ENGINEERS AND EXECUTIVES—This confidential service for outstanding men who desire positions paying $5,000 to $40,000 will develop preliminary negotiations with reputable organizations without risk to present position. For complete details, send experience record and expected salary range. Tomsett Associates, 337 Frick Bldg., Pittsburgh 19, Pa.

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This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions, assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited.

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Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

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. . . especially the realistic and liberal tolerances in Section 7 of this document for various gear blank elements to produce gears of given degrees of accuracy.

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These American Standards are published by and obtainable from

The American Society of Mechanical Engineers

29 W. 39 St., New York 18, N. Y.

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They're asking for help that only you, through your Red Cross, can give. They're asking you to help the hand that helps so many in moments of need.

So remember the appeal in the eyes of this little girl when your Red Cross worker calls. Remember, too, he's asking for those who can't ask for themselves—give and give generously through your Red Cross!

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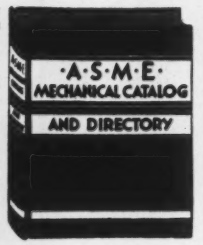

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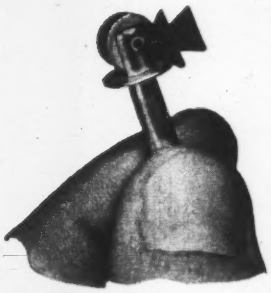
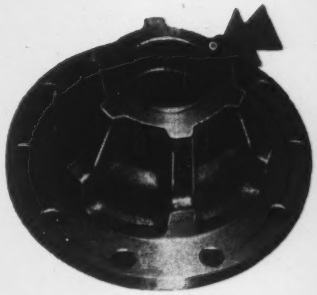
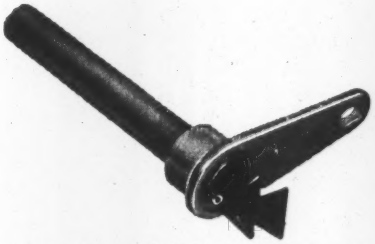


AS A SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.

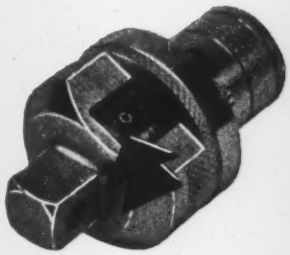


AS A DOWEL . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.

AS A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application above is with the plate of a home workshop tool.



AS A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than usual assemblies.



AS A STOP PIN . . . in this application, Rollpin is shown in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.

AS A SIMPLE FASTENER . . . Rollpin replaces a set screw in pinning a gear to a shaft. Assembly time is shorter, service life longer. Vibration-proof flush fit. Easily removable.

YOUR IMPORTANT FASTENING JOBS

are cheaper . . . faster, with ROLLPIN

TRADE MARK

Rollpin is a pressed-fit pin with chamfered ends. It drives easily into holes drilled to normal tolerances, compressing as driven. No reaming, no tapering, no extra assembly steps required. Rollpin fits flush, *locked* in place by the constant pressure it exerts against the hole walls. Can be inserted with automatic press, or by hand—removable with a drift or pin punch.

Rollpin is reusable again and again.

Elastic Stop Nuts with the famous red collar are another ESNA product

ESNA

MAIL COUPON TODAY. If your present operations or plans include the above applications—or set screws, rivets, hinge pins, cotter pins, pivot pins, taper pins—you can't afford to be without complete details on Rollpin. Write now—find out how much faster and cheaper Rollpin can do the job.

Dept. R1-511 Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, N. J.

Please send me the following free information on ESNA self-locking fasteners:

- ☐ Rollpin bulletin and sample Rollpins
- ☐ AN-ESNA conversion chart
- ☐ Elastic Stop Nut Bulletin
- ☐ Here is a drawing of our product. What fastener do you recommend?

Name _____ Title _____

Firm _____

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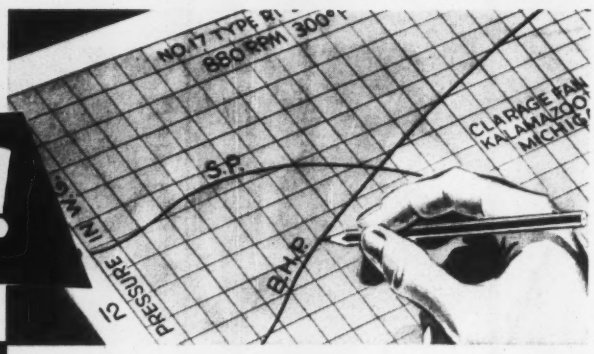

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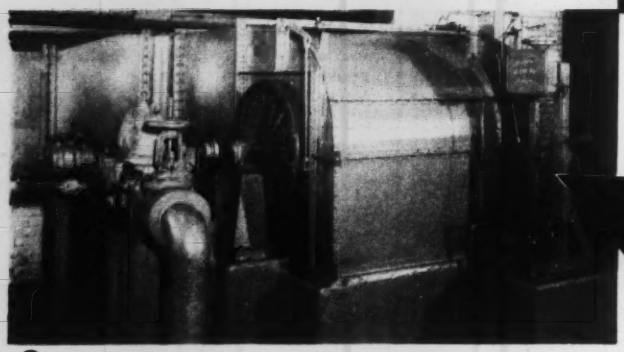
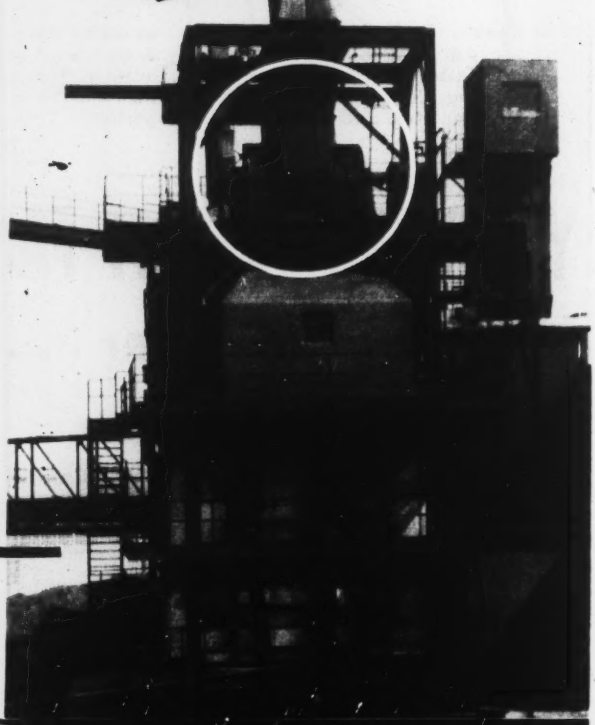


built right!



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We are specialists with long experience in meeting mechanical draft problems.

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Boiler and stoker manufacturers have a high regard for Clarage engineering and construction. Ask anyone of them, or write us for detailed information.

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Three Cleveland 10RT speed reducers (with 3" centers) on a six cylinder gang pump installed in a California oil plant. Two of the worm gear units drive pumps at 88 strokes per minute, the third at 70 strokes per minute. Photo by courtesy of Milton Roy Company.

Small CLEVELANDS provide wide range of stroking speeds for Milton Roy pumps

THIS Milton Roy controlled volume pump meters 3 liquids in exact ratio—fatty acid, sulphuric acid, and glycerin, delivered at differing speeds.

To provide the variation of stroking speeds necessary and to insure accurate control of proportioning and volume, the pump builder uses three small Cleveland worm gear reducers with a variable speed motor.

Cleveland worm gear units take up a minimum of space. They transmit power with a smooth, uniform torque flow. Case-hardened steel worms mesh with nickel-bronze gears for long, hard, dependable service without appreciable wear. Throughout the chemical and allied industries, you'll find Clevelands—big and small—driving pumps, agitators, mixers—in fact, every kind of equipment for which a right-angle drive is needed.

If you have a power transmission problem, you can get help by writing for Catalog 400. The Cleveland Worm & Gear Company, 3264 East 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND

Speed Reducers

New Bullard vertical chucking grinder gets high precision, handles heavy loads with table on TIMKEN® bearings

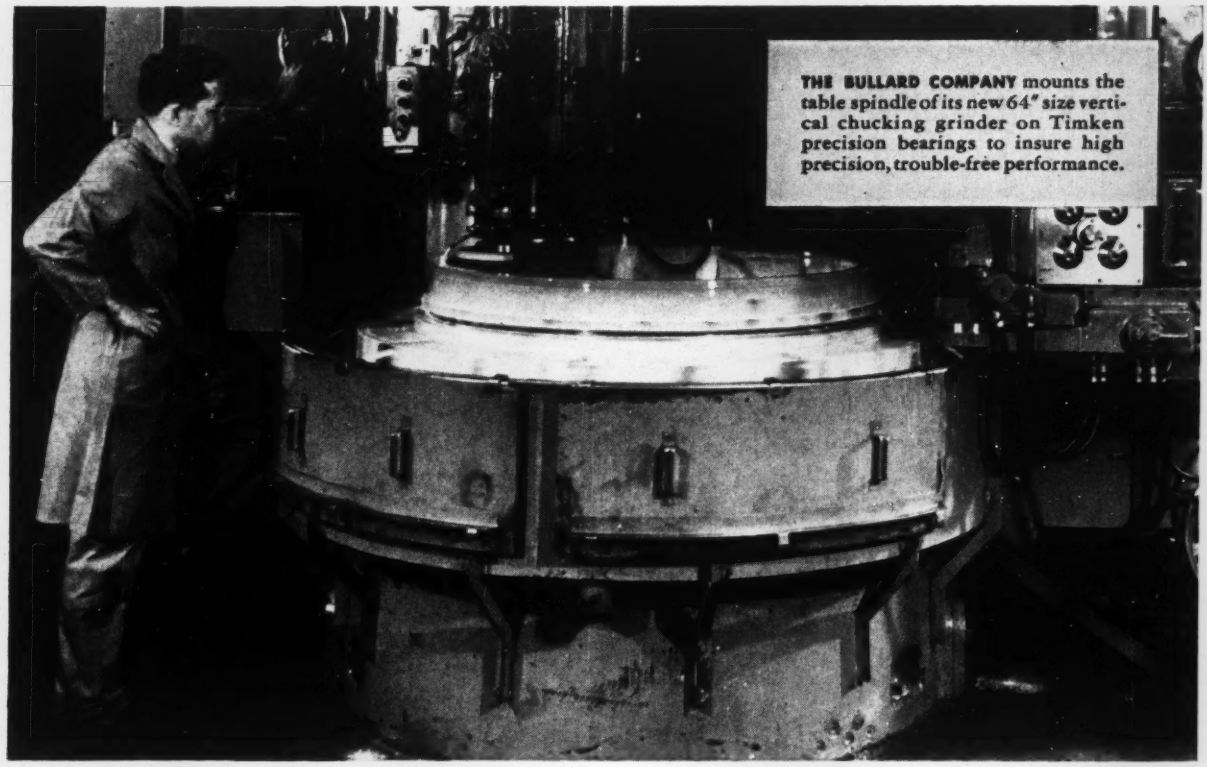
TO insure the high precision needed in finishing cups and cones for large-size roll neck bearings, Bullard mounted the table spindle of a new 64" size vertical chucking grinder on Timken® tapered roller precision bearings. Timken bearings are also used in many other vital spots.

Line contact between their rollers and races gives Timken bearings extra load-carrying capacity. Their tapered construction takes radial and thrust loads in *any* combination. Result: Shafts are held in rigid alignment. Shaft deflection and end-play are minimized. Gears mesh smoothly. Spindle precision is assured.

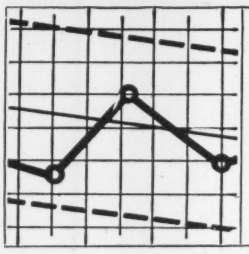
True rolling motion and an incredibly smooth surface finish make Timken bearings practically friction-free. Maintenance and lubrication time and costs are cut to a minimum.

Precision manufactured, made of Timken fine alloy steel and engineered for the job, Timken bearings normally last the life of the machine. Specify Timken bearings in the machinery you build or buy. Look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



THE BULLARD COMPANY mounts the table spindle of its new 64" size vertical chucking grinder on Timken precision bearings to insure high precision, trouble-free performance.



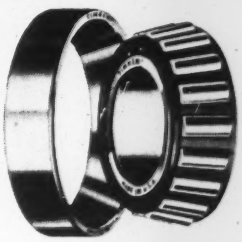
STATISTICAL QUALITY CONTROL

To insure uniform high quality and closer tolerances, the Timken Company uses statistical quality control. With it, tolerance deviations are plotted graphically. It's one of industry's newest, most scientific methods of improving product uniformity.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION →◎←